Laetoli hominid 18 : studies on a pleistocene fossil human skull from northern Tanzania.

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LAETOLI HOMINID 18: STUDIES ON A PLEISTOCENE FOSSIL HUMAN SKULL FROM NORTHERN TANZANIA

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ABSTRACT

Laetoli Hominid 18 cranium was recovered in 1976 from the Pleistocene Ngaloba Beds at Laetoli, Northern Tanzania. The cranium is well preserved and consists of an almost complete cranial vault, much of the base, both temporal bones and part of the sphenoid bone. The face together with part of the upper dentition is only partially preserved. Associated with the Laetoli Hominid 18 cranium, were a number of artifacts and a few faunal remains. The dating of the Laetoli Hominid 18 cranium is about 120,000 years Before Present (B.P.). In this study, a full anatomical and metrical description of the external and internal morphological features of the Laetoli Hominid 18 cranium is given, and the cranium is compared anatomically and metrically with both fossil and modern human crania in order to define its taxonomic relationships. Multivariate statistical analysis was employed to investigate the metrical features of the cranium.

The comparative sample included fossil crania ranging from *Homo erectus* to *Homo sapiens* specimens. The sample included specimens from sub-Saharan Africa, North Africa, the Middle East, the Far East/Australia and the European materials. The modern human sample was drawn from the African Ngoni, Ashanti and Kaffir groups.

The morphological examination combined with the statistical analyses indicates that the Laetoli Hominid 18 cranium is an early East African example of sub-Saharan

Homo sapiens of the Upper Pleistocene age. The cranium shows a combination of modern and archaic features. The overall expansion of the cranial vault, the bossing of the parietals, the roundness and fullness of the occipital region, the low position of the inion, the U-shaped dental arcade, the great depth of the palate, the pear-shaped nasal opening, the development of the tympanic region, the symmetrical arrangements of the vascular and cerebral markings as well as the cranial capacity of 1200 cm^3 places the Laetoli Hominid 18 cranium nearer to the modern sapients. In contrast, however, to the above modern features, the low receding, flattened and slightly keeled frontal bone, the large brow ridges, the low markings of the temporal ridges, the marked bone thickness, the small mastoids, the large occipitomastoid crest, the developed and centrally limited occipital torus are archaic features.

The significance of the mosaic of the features is discussed in terms of the evolutionary history of man in Africa.

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I. INTRODUCTION

In 1976 parts of a fossil human cranium now designated Laetoli Hominid 18 (L.H. 18), were found *in situ* within the Ngaloba Beds at Laetoli, Northern Tanzania. This discovery is of importance for the following reasons:

1. The fossil bone fragments, when reconstructed, formed an almost complete cranium.
2. The discovery adds to the sample of Pleistocene fossil hominid remains already recovered from Africa and elsewhere.

The central aim of this thesis is to furnish an anatomical and metrical description of the external and internal morphology of Laetoli Hominid 18 cranium and to compare it anatomically and metrically with both fossil and modern human crania in order to define its taxonomic relationships. The cranium of Laetoli Hominid 18, being a new find should increase our present knowledge of the evolutionary history of man as a whole. With the rapid developments in research of human origins in Africa, and in Tanzania in particular, there is also an urgent need for local scientists to play an active role in this research.

LOCATION OF LAETOLI

Laetoli lies in the Northern parts of Tanzania, between 3^{o} 07' - 3^{o} 15'S and 35^{o} 10' - 35^{o} 15'E, and covers an area of about 30 km^2 (Oakley et al., 1977). The site is about 20-30 miles South of the Olduvai Gorge camp (Plate 1A).

THE NAMES LAETOLIL AND LAETOLI

Laetolil is the original name first proposed by Kent, (1941), to describe both the area and the early fossiliferous deposits exposed at the site. This name is based on the Anglicised version of the Masai name (Laetoli) for *haemanthus*, a red lily that is abundant in the locality. Later, the name Laetolil was used by M.D. Leakey et al., (1976), in preference to either Garusi or Vogel river series in describing the area where the Laetolil Beds are exposed. In 1979, the Tanzanian authority discarded the use of the Anglicised version Laetolil in favour of Laetoli when describing the area. According to M.D. Leakey, the name Laetolil Beds as established in 1976, should continue to be used when describing the Pliocene deposits exposed at the site (Leakey and Hay, 1979).

THE HISTORICAL BACKGROUND OF LAETOLI

Hominid discoveries at Laetoli date back to 1939 when L. Kohl-Larsen made an extensive collection of fossils

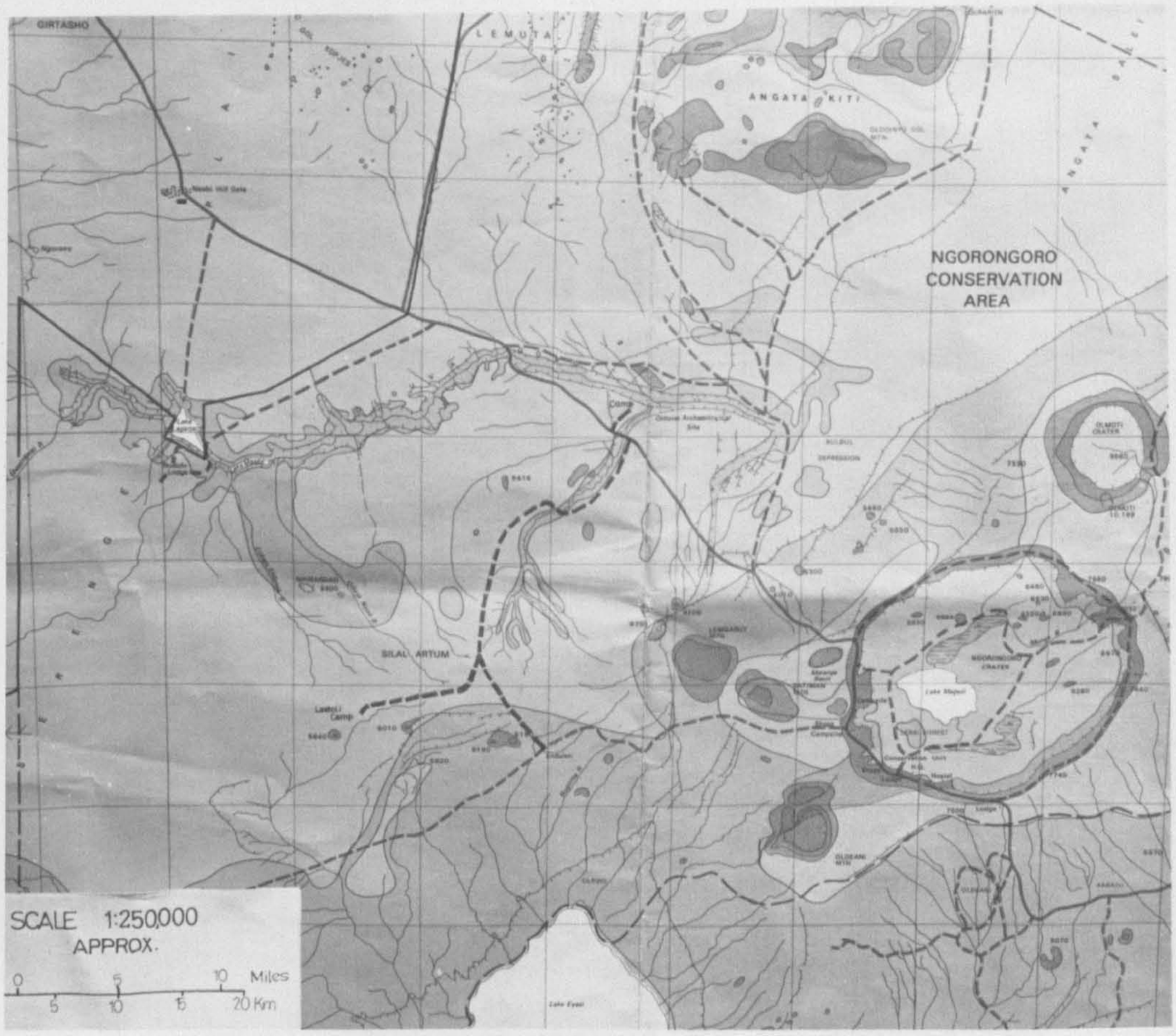


PLATE 1A: Map of the northern part of Tanzania showing the Laetoli area.

that includes a piece of hominid maxilla (*Meganthropus africanus*) named by Weinert (1950). The site however, has been known since 1935 when it was first visited by an archaeological expedition led by the late Dr. L.S.B. Leakey accompanied by his wife, Dr. M.D. Leakey. For a period of about 30 years, little attention was paid to the site but interest was revived in 1974 by the initiative of Dr. M.D. Leakey, after the discovery of fossil equid and bovid teeth in the bed of the Gagjingero river by G. Dove (Leakey et al., 1976). Following this discovery, a seasonal camp at Laetoli was established by Dr. M.D. Leakey and further fossil hominid specimens were recovered during the 1974 and 1975 palaeontological investigations. The remains included mandibles and teeth, recovered from reliably dated deposits of Pliocene age (White, 1976). Today, the Laetoli site has proved to be one of the richest sites in Africa for the fossilised remains of extinct mammals.

THE DISCOVERY OF LAETOLI HOMINID 18 CRANIUM

Among the discoveries made during the 1976 field season were the remains of a fossil human cranium. The cranium designated as Laetoli Hominid 18 (L.H. 18), was found by E. Kandini, a trained and experienced field assistant. He first saw an isolated tooth, (left M^1), partially exposed and emerging from the ground at Locality 2 (Plate 1B). Later, when the site was visited by a team led by Dr. M.D. Leakey, Mr. P.E. Leakey recovered

PLATE 1B: The site of the discovery of the Laetoli Hominid 18 cranium at Locality 2, Laetoli. The site is marked by a concrete slab, numbered L.H. 18 and lies within the Ngaloba Beds. These are stream deposits, principally sandstones and claystones, of which only patches are preserved in the vicinity of Laetoli.

several fragments of an unusually thick cranium, eroding from a ridge about two metres away from where the tooth had been found and separated from it by a three-foot deep gully.

A careful excavation was conducted at the site by M. Jackes, of the University of Toronto, with the assistance of two trained field assistants who unearthed further cranial remains. The greater part of the cranium was found in a fragmentary state but lying *in situ* within an area of under one square metre. Sections exposed by the trenches indicated that the cranium lay within a 2-metre thickness of the Ngaloba Beds at Locality 2 close to the eroded surface of the underlying Ndolanya Beds (Leakey, M.D., 1978, pers. comm.). Associated with the Laetoli Hominid 18 cranium, were a number of artifacts and a few faunal remains that included fossil reptilian and avian bones as well as fossil mammalian bones. The entire surrounding surface area was carefully checked and sieved in the hope of recovering additional fossil fragments and subsequent excavation at the site yielded no further hominid fossil materials. The specimen was taken to Laetoli camp from where it was transferred at first to the Kenya National Museum in Nairobi and later to London for further study.

THE STRATIGRAPHY OF THE LAETOLI AREA

The stratigraphy of the Laetoli area was first studied and briefly described by Kent as a member of the

1934-35 expedition (Kent, 1941). Kent recognized three main sub-divisions of the stratigraphic sequence which overlies the metamorphic complex of Precambrian age. The lower unit, he named the Laetolil Beds, consisting of sub-aerially deposited tuffs and gave a thickness of about 5 m at the type locality; the upper unit (Ngaloba Beds), consisting of tuffaceous clays,and a middle unit consisting of olivine-rich lava flows and agglomerate, which is much closer in age to the Laetolil Beds than to the Ngaloba Beds.

Following the stratigraphic work by R.L. Hay 1974-75, the stratigraphic picture of the Laetoli site has now been greatly modified (Leakey et al., 1976; Leakey and Hay, 1979). Hay, as Kent, sub-divides the stratigraphic sequence at Laetoli into three main units; a Lower unit, the Laetolil Beds; a Middle unit, the Ndolanya Beds; and an Upper unit, the Ngaloba Beds.

THE NGALOBA BEDS

The Ngaloba Beds are stream deposits, principally sandstones and claystones and are separated from the underlying Ndolanya and Laetolil Beds by vogesite lava (Leakey et al., 1976; Leakey and Hay, 1979). Only patches of the Ngaloba Beds are preserved in the vicinity of Laetoli. Most of the Laetoli Hominid 18 cranium was found *in situ* within a 2 m thickness of the Ngaloba Beds close to the eroded surface of the underlying Ndolanya Beds.

The exposure at the type locality that yielded Laetoli Hominid 18 cranium principally consists of sandy claystones and contains a water-worked vitric tuff. The tuff is trachytic and contains the pyroclastic minerals biotite and anorthoclase.

Preliminary attempts in obtaining a chronometric date for the Ngaloba Beds by the radio-carbon (C^{14}) dating method and by amino-acid racemisation measurements have so far been unsuccessful. However, from the geological, archaeological and faunal considerations, the Ngaloba Beds are tentatively correlated with the marker tuff in the lower unit of the Ndutu Beds at Olduvai Gorge, estimated at 120,000±30,000 years B.P.

THE NDOLANYA BEDS

The Ndolanya Beds lie between the Laetolil Beds and the vogesite lava (Leakey and Hay, 1979). The Beds have a maximum thickness of 22 m and are divisible into an upper and a lower unit separated by widespread pedagenic calcrete 30 to 100 cm thick and in places by a channelled erosional surface. Much of the lower unit with an overall yellowish-gray colour is dominantly aeolian tuff but also contains a wind deposited clay-pellet aggregate and nodular limestone of ground-water origin. Most of the ash particles are essentially similar to those of the Laetolil Beds except for a coarser grain size for the upper tuff of the Laetolil Beds. The upper unit

consists of aeolian tuffs of grayish-brown colour and nephelinite composition. It is significantly younger than the lower unit in view of the calcrete and eroded surface at its base. The age of the Ndolanya Beds is bracketed between 2.4 and 3.6 m.y. They are probably closer to 3.6 than 2.4 m.y. in view of their mineralogical affinity to the Laetolil Beds (Leakey and Hay, 1979).

THE LAETOLIL BEDS

The Laetolil Beds have a maximum known thickness of 130 m and are divisible into a lower and an upper unit. The upper unit, mostly wind worked aeolian tuff, is 45 m to 60 m thick. Most of the early fossiliferous materials have been recovered from this unit. The aeolian tuffs are massive deposits consisting of nephelinite and melilitite ash re-worked and deposited by wind (Leakey and Hay, 1979). In 1975, three prominent marker tuffs designated as a, b and c were identified and used for correlations in the upper unit. Since then, several other air fall tuffs have been recognised; of these eight of them numbered 1-8 are presently the principal tuffs now used for correlations.

The lower unit consists of interbedded ash-fall and aeolian tuff with minor conglomerate and breccia (Leakey et al., 1976). The age of the Laetolil Beds has been estimated by K-Ar methods as being 3.6-3.75 m.y. B.P.

FAUNA AND ARTIFACTS ASSOCIATED WITH THE LAETOLI HOMINID 18 CRANIUM

Associated with the Laetoli Hominid 18 cranium were a number of artifacts and a few fragmentary faunal remains (Leakey, M.D. pers. comm., 1978).

The faunal remains include some fossil reptilian and avian bones as well as fossil mammalian bones. The reptiles are represented by a number of snake vertebrae while the avian remains are represented by fragments of ostrich egg-shell. The mammalian bones include, a broken bovid mandible, a bovid atlas, the head of a bovid femur and a carnivore phalanx.

A total number of 392 artifacts were associated with Laetoli Hominid 18 cranium. The artifacts include both the *in situ* and the surface collections.

The *in situ* artifacts amounted to 51 specimens of which 40 were found when excavating the site where the Laetoli Hominid 18 cranium was recovered. The other eleven *in situ* artifacts were recovered from a geological trench a short distance from the site where the cranium was found. The *in situ* specimens include: one bifacially trimmed tool made from fine grained quartzite, seven flakes with faceted platforms, nine flakes with unmodified platforms, one small quartzite scraper, one small high-backed disc core of quartzite, 25 broken flakes and seven quartzite core fragments.

The surface artifacts amounted to 341 specimens that were found eroding from the surface of the Ngaloba Beds and were collected over an area of approximately 170 square metres, in the vicinity of the site. Similar artifacts are also abundant on the surface over the greater part of the Laetoli area where the Ngaloba Beds are exposed. The surface materials include, 39 flakes with faceted platforms (similar to the *in situ* specimens), 60 flakes with unmodified platforms (also similar to those that were *in situ*), five scrapers, twelve notched flakes, three specimens consisting of a spheroid, a polyhedron and chopper, six outils ecailles, 41 utilised flakes, fifteen specimens of typical prepared cores, one hammerstone, 98 broken flakes and 61 core fragments.

The surface materials correspond closely to the more limited *in situ* series and appear to be a single cultural entity without admixture of either earlier or later elements. The industry is characterized by prepared cores and convergent, triangular flakes with broad, thick platforms that are generally faceted, but sometimes unmodified (Leakey, M.D., pers. comm., 1978).

The industry can be attributed to the Middle Stone Age cultural complex and resembles that from the Lake Eyasi foreshore site where L. Kohl-Larsen discovered human remains described as *Palaeoanthropus njarasensis*; similarities also exist with the industry from the upper Ndutu Beds at Olduvai Gorge (Leakey, M.D., pers. comm., 1978).

II. REVIEW OF THE LITERATURE ON HOMINID FOSSIL CRANIA FROM THE LATE MIDDLE AND UPPER PLEISTOCENE OF EAST AFRICA AND ELSEWHERE

In recent years, East Africa has emerged as one of the most important areas in the study of human origins. This has been due mainly to the favourable geological and geographical conditions of the locality and to the remarkable contributions made by the late Dr. L.S.B. Leakey. A number of important fossil hominid crania, attributed to the late Middle and Upper Pleistocene have been recovered from various localities in East Africa including, Tanzania, Kenya and Ethiopia. These fossil hominid crania, now widely regarded as attributable to *Homo sapiens*, form an important group in the study of the later stages of human evolution. It is from their study that we can add more to our present understanding of the *Homo erectus/Homo sapiens* transition in human evolution which is still poorly documented in East Africa and indeed in the world as a whole.

The study of fossil hominids from the later Pleistocene period in East Africa is complicated and leaves many problems unsolved. In the past, much attention has been centered on the study of the earlier hominids but the later hominids have received relatively little attention. One of the major problems encountered in the study of the later hominids in East Africa is often the lack of sufficient evidence regarding the precise site,

geology and stratigraphy of the discoveries, on occasion leading to great difficulties in the dating of the materials. Some of the specimens result from surface collection while others have been recovered from areas lacking datable materials; thus, accurate dating of these fossils is a recurring problem. However, with new approaches in the study of human evolution tending to be of a more interdisplinary character, many of the above problems are receiving attention. The contributions of specialists dealing with geomorphology, dating and environmental studies has played an important role in the study of the later stages of human evolution in East Africa. Above all, the opening in 1977 of the Leakey Memorial Institute for the study of the Prehistory, is another major achievement in East Africa which will assist the study of our evolutionary history.

In this chapter, relevant known fossil hominid crania will be reviewed according to their geographical distribution, location, circumstances of the discovery, faunal association, archaeological association, affinities and dating.

A. HOMINID FOSSIL CRANIA FROM THE LATE MIDDLE AND UPPER PLEISTOCENE OF EAST AFRICA

1. Kanjera (Kenya)

The Kanjera site is situated on the eastern shores of Lake Victoria and was first discovered between 1911 and

1912 by F. Oswald (Oakley et al., 1977). The importance of this site for the study of the origins of man, was revealed in 1932 when L.S.B. Leakey, leading an archaeological expedition, recovered a number of fragments of fossil hominid skulls with a femoral fragment. The Kanjera specimens numbered (Kanjera 1-5), are heavily mineralised and probably represent five different individuals as follows:

Kanjera 1: Consists of seven fragments of the frontal, parietal and occipital bones.

Kanjera 2: Consists of three fragments of parietal bone and some rib fragments.

Kanjera 3: Consists of eight fragments of frontal, parietal occipital, femoral and phalangeal bones.

Kanjera 4: Consists of two fragments of frontal bone.

Kanjera 5: Consists of two fragments of femur.

Some of the Kanjera specimens were picked up from the surface and some were found *in situ*. Associated with the specimens were faunal remains that included, *Elephas recki* together with a few implements attributed to the "Chellean" industry (Boswell, 1935). The geology of the Kanjera site is still uncertain and the dating of the site has never been accurately established. Leakey (1932), on the basis of the morphological appearances of the specimens and the associated faunal remains, considered the Kanjera specimens to be attributable to *Homo sapiens* of Middle Pleistocene age. Leakey's views were accepted at first at a conference at Cambridge in 1933. Later, investigations made by Boswell in 1935 (instigated by the

Royal Society) at the site of the discovery, cast doubts on the scientific value of the Kanjera specimens since there was not enough evidence regarding the precise site and stratigraphical levels of the discoveries. However, earlier comparisons of the fluorine content of the human bones from Kanjera with that of the fauna supported the provisional conclusion that they were contemporaneous. Recently, it has been shown that relative dating by fluorine method is not reliable compared to the radiometric assay in volcanic areas particularly under tropical conditions (Oakley, 1974). The recently revised dating of the Kanjera hominid fossils (Oakley, 1974), by radiometric assay shows that the hominids are much younger than the faunal remains which are of Middle Pleistocene age, and are probably of Upper Pleistocene age.

2. Eyasi (Tanzania)

The Eyasi site is situated at the north-east end of Lake Eyasi (formerly known as Lake Njarasa), about 2 km from the Mumba Hills (Oakley et al., 1977). During the course of a scientific expedition to the Eyasi site, between 1934 and 1936, L. Kohl-Larsen discovered about 200 fragments of fossil hominid skulls. After study, the fragments seemed to represent at least three different individuals identified as Eyasi I to III.

The three Eyasi skulls were found exposed in sandstone deposits in the floor of the present lake basin

as a result of recession of the waters during the dry season (Leakey, 1936). Three strata of the deposits were recognised by L. Kohl-Larsen and Reck (1936) and later this was confirmed by Leakey and Reeves (1946) during their visit to the site. It was the middle stratum (reddish-coloured bed) that yielded most of the Eyasi specimens. Associated with the hominid fossil skulls were numerous faunal remains together with stone artifacts. The faunal remains, like the hominid fossil skulls, were fragmented and heavily mineralised. Two groups of the faunal remains were recognised, the rolled and the unrolled. The unrolled faunal remains constituted the majority and included bones and teeth representing zebra, giraffe, pig, rhinocerus and hippopotamus (Leakey, 1936), all of which are derived from recent fauna. The rolled fauna include a few teeth of *Hipparion* and a large *giraffid* attributed to the Middle Pleistocene. The stone artifacts were also unrolled and are said to be contemporaneous with the unrolled fauna and the fossil hominid crania. Kohl-Larsen and Reck (1936), estimated the age of the unrolled fauna and associated artifacts to be 35,000 years before present (B.P.). Similar conclusions were reached by Leakey (1936) who placed the materials to an Upper Pleistocene (Gamblian) period.

The Eyasi skulls as a whole, are poorly preserved and heavily mineralized. Only the Eyasi I skull is reasonably well preserved and has received more attention than the other two. Previously, the skulls have been attributed to new taxa such as *Palaeoanthropus* (Kohl-Larsen

and Reck (1936) and *Africathropus njarasensis* (Weinert, 1939). However, Leakey (1936), judging from the morphological features, pointed out that the Eyasi I skull was in his view, closely related to the *Pithecanthropus* group but he was aware of the fact that such a statement was in need of other evidences such as its geological, palaeontological and cultural associations. Weinert (1937), however, strongly believed that the Eyasi I skull was, without doubt, a member of the *Pithecanthropus* group and discounted the geological and palaeontological evidence given by Reck, Kohl-Larsen and Leakey in 1936.

Today, it is held that the Eyasi I skull shows many resemblances to other African fossil hominid skulls such as the Broken Hill (Kabwe) and Saldanha specimens (Wells, 1957; Protsch, 1976 and Howell, 1978). In addition, the Eyasi I skull also shows a number of similarities with the more recently discovered fossil hominid skulls like Laetoli Hominid 18, Ndutu (Clarke, 1976) and possibly Bodo (Conroy et al., 1978).

The absolute date of 34,000 to 35,000 years B.P. given to the Eyasi I skull places it outside the known range of the *Homo erectus* group (Protsch, 1976).

3. The Omo River Region (Ethiopia)

The site lies within the lower basin of the Omo River, south-west Ethiopia (Leakey et al., 1969). The

International Omo research expedition included three teams, one each from Kenya, France and the United States of America (Leakey, 1969). The expedition was organized to investigate the Plio/Pleistocene deposits in the lower basin of the Omo River. There, in 1967, the Kenyan group led by R.E.F. Leakey, recovered parts of three skeletons including two calvaria, some cranial fragments and numerous fragments of postcranial bones (Day, 1969). The hominid fossil crania, numbered Omo I-III, were recovered from two known sites. Site (KHS) produced Omo I, site (PHS) produced Omo II but no information is available concerning the site of Omo III (Day, 1971).

The Omo hominid fossil remains are still under investigation and study but a preliminary anatomical description of the crania has so far been reported by Day (1969 and 1971). Omo I consists of an incomplete vault, parts of the mandible and both maxillae, a zygomatic bone and two tooth crowns together with postcranial material, all belonging to the same individual. Omo II is the best preserved calvaria of the three, consisting of an almost complete cranial vault. Omo III consists of a glabella and a fronto-parietal fragment.

The hominid fossil crania were recovered from a large area (Leakey, 1969) but from the same level of sediments within the Kibish Formation (Day, 1971). The Kibish Formation (Butzer, 1969) consists of five major sub-divisions. The first three members, I, II and III consist

of delta-fringe and prodeltaic sediments with accumulative thickness of at least 108 m. The Omo I and II crania were all recovered from Member I of the Kibish Formation.

The Omo I and II crania are of particular interest in that apart from their recovery from the same level of sediments, they are strikingly dissimilar in their morphological appearance. Thus, the Omo I cranium, unlike Omo II, looks more modern in appearance. Due to the great diversity in the morphological appearances of the two crania, Rightmire (1976) has expressed doubts regarding their affinity. Day (1969 and 1971) expressed the view that if the two Omo crania are contemporaneous they represent a segment of evolving African Upper Middle Pleistocene *Homo sapiens* that show a diversity of skull form. Within each skull further evidence of mosaic evolution was shown. Such a view, seems to be supported by the more recent discoveries of the Ndutu, Bodo and Laetoli Hominid 18 crania, which still further demonstrate the evidence of mosaic evolution and are probably of the same approximate age.

Also, recovered from the Kibish Formation were a number of faunal remains that includes, *Colobus*, a complete skeleton of *Synerus aff. caffer, Elephas loxodonta* and *E. recki* (Leakey, 1969). Only the Omo I cranium was associated with a small number of stone artifacts and some animal debris.

The dating of the Omo materials remains uncertain. From the geological evidence, Omo I and II are contemporaneous and probably of Upper Middle Pleistocene age (Leakey, Butzer and Day, 1969). The dating of the Kibish Formation on the basis of Th230/U234 gave an age of 130,000 years B.P. With further evaluations of the Omo materials still taking place, it is hoped that more information regarding their affinities will yet be brought to light.

4. Kabua I skull

The skull was found in 1959 by T. Whitworth, 1143 m SSE of Kabua water hole, Turkana District, in Upper Pleistocene lacustrine deposits (Oakley et al., 1977).

A fuller account of the Kabua I skull was given by Whitworth (1966). As reported by Whitworth (1966), the Kabua I skull is almost complete, lacks only the face and the left side of the jaw, but has suffered from some post-mortem damage. It is a long skull, narrow and with thickened walls. The face appears to have been small and there is no suggestion of developed supraorbital torus. However, the jaw appears to be robust and the mandible shows to have possessed a chin. All of the molar teeth are badly worn.

Numerous surface collections of artifacts were also later collected at the site of the find and these include

Middle Sangoan hand axes and Levallois type flake tools. The faunal remains collected at the neighbouring sites are of indeterminate nature.

According to Whitworth (1966), the Kabua I skull shows some similarities in morphology to some other African fossil skulls, including the Kanjera skulls, in the lowness of the cranial vault and the thickness of the bones. However, the Kabua I skull diverges from the Kabwe and Saldanha in the development of the supraorbital region and in the morphology of the occipital bone. Thus, the Kabua I skull unlike the Kabwe or Saldanha has moderately developed brow ridges and the occiput is well rounded and filled.

The precise dating of the Kabua I skull has not been possible. However, the human remains were found resting in ancient lake sediments believed to be of Upper Pleistocene age. Due to poor preservation technique the Kabua I skull is now of little comparative value.

5. Ndutu (Tanzania)

The site is situated on the north shore of Lake Ndutu, Serengeti plain (Oakley et al., 1977). The Ndutu cranium was discovered between September and October 1973 by A.A. Mturi during a palaeontological and archaeological survey at the site.

A preliminary anatomical description of the cranium together with a report on the geology, faunal and cultural associations has been written by Clarke and Mturi (1976). As reported by Clarke, the Ndutu cranium is well preserved and consists of a complete occipital and left temporal bones, the right temporal bone lacking the glenoid fossa, parts of both parietals and the right side of the frontal bone, parts of the sphenoid together with a fragmentary central region of the face still attached to a fragment of the maxilla. From the morphological appearances, Clarke (1976) concluded that the Ndutu cranium shows both archaic and modern features; in its archaic features, the cranium has strong resemblances to *Homo erectus pekinensis*, "its more advanced characteristics and its occurrence in Africa rather than Asia may eventually warrant the creation of a new sub-species of *Homo erectus* to accommodate it". This view has not so far been supported.

The Ndutu cranium was found within the Ndutu deposits that comprise a claystone member, sub-divided into a greenish sand/clay unit, 15-45 cm thick, underlain by 60 cm of sand-free green clay with chert nodules in the lower unit. The cranium rested on the silty sub-unit of the sand/clay unit. Associated with the cranium were stone artifacts of a non-descript and indeterminate industry together with abundant faunal remains. The presence of numerous faunal remains suggest that the area may have been a butchering site (Mturi, 1976). Two theories

have been put forward by Mturi (1976) to try to explain the absence of tool types of the Acheulean industrial complex at the site which are found in abundance in the neighbouring Olduvai Gorge and other sites in Tanzania. Mturi (1976), suggested that the industry at the site really belongs to Acheulean and that the area excavated is only an indication of "activity patterning".

Attempts to date the Ndutu site have so far been unsuccessful, but one preliminary chronometric date obtained by amino-acid racemisation measurements of bone obtained from the occupational floor gave a general age of 500,000-600,000 years B.P. This would seem to be older than would be expected and suffers from the general criticisms levelled at this dating technique such as lack of calibration.

6. Bodo D'Ar (Ethiopia)

The site is situated in the north-western Hararghe Province (Ethiopia). The Bodo skull was discovered between the autumn 1976 and March 1978 by a joint palaeontological, geological and archaeological survey team in the Awash River Valley, Ethiopia (Conroy et al., 1978).

A preliminary report on the Bodo skull together with mention of the stratigraphy, geology, faunal and cultural associations has been given by Conroy et al., (1978). The skull is of much interest in that it is well preserved

and almost complete. It consists of an almost complete face together with a partially preserved vault and cranial base. The cranial vault includes much of the frontal bone, both parietals, the right side of the occipital bone and parts of the left temporal bone. Most of the cranial base anterior to the basin is preserved.

The Bodo skull was found exposed as a result of weathering out of the surface of the Upper Bodo unit. The fossil skull fragments were collected from separate areas but within reasonable distances apart and when pieced together they formed the skull. Associated with the skull, were numerous faunal remains together with artifacts derived from layer B of the Upper Bodo Beds attributed to the Middle Pleistocene (0.7-0.125 myr. B.P.). The high percentage of faunal materials seemed to suggest that the area was probably a butchering site (Conroy et al., 1978).

As reported by Conroy et al., (1978), the Bodo skull has close similarities to both the Broken Hill and Petralona skulls. Fuller assessments of the Bodo skull still await anatomical investigation accompanied by a range of comparative studies.

B. HOMINID FOSSIL CRANIA FROM THE LATE MIDDLE AND UPPER PLEISTOCENE IN OTHER PARTS OF AFRICA

1. The Kabwe skull (Zambia)

This famous skull was found during an open-cast mining operation by T. Zwigelaar on the 17 June, 1921 at Kabwe (formerly Broken Hill N. Rhodesia), Zambia (Oakley et al., 1977). In addition to the skull, other human fossil remains were recovered by A.S. Armstrong, 1921; A.W. Whittington, 1921 and H. Hrdlička, 1925. In all, the recovered human remains represent at least three and probably four individuals comprising of a skull, a parietal, a maxilla, a humerus, a sacrum, two ilia and several fragments of two tibiae.

The circumstances of the discovery were archaeologically unsatisfactory. The mine included two small kopjes (hills) consisting of limestone richly impregnated with ores of lead, zinc and vanadium. One of the hills was tunnelled at its base by a cavern known for its extraordinary abundance of fossilised and mineralized animal-bone remains. The skull was found at its furthest and deepest point about 60 feet below the ground level. Subsequent excavations produced the rest of the remains while continued quarrying destroyed the original cave site leaving only a large open pit.

It is believed that the Kabwe fossils were associated with an early African Middle Stone Age industry known as Proto-Stillbay, together with faunal remains. The fauna remains were reviewed by Cooke (1964) and include,

Herpestes ichneumon, *Panthera leo*, *Panthera pardus*, *Leptailurus hintoni*, *Loxodonta africana*, *Equus burchelli*, *Diceros bicornis*, *Homoioceras bainii* and *? Simpithecus sp.*

For a very long time the Kabwe fossils have been the subject of study and discussion. The morphology of the skull has been detailed in a number of early publications. In the first account of the skeleton Woodward (1921) noted the similarity of the Rhodesian skeleton to that of the Neanderthal or Mousterian race but nevertheless gave the specimen a new species of man, *Homo sapiens* on the basis of the anteriorly positioned foramen magnum. This view was disputed by Pycraft (1928) whom, after observing the pelvic bones was convinced that the Rhodesian man had walked about with a stoop and so he created a new genus *Cyphanthropus* (Bent-over Man). Morant (1928) however, from the metrical analysis came to the conclusion that though Kabwe man showed characters similar to those of *Homo sapiens*, he had closer resemblances to Neanderthal man.

For many years, the discovery of Kabwe man remained a puzzle to earlier workers. At the time, Kabwe man was the only specimen of its kind in the sub-Saharan region and moreover its cultural, geological and faunal association was only vaguely understood. Some of the above doubts were cleared up after the discovery of the Saldanha skull in 1953 by Singer and by subsequent studies. Singer (1954) regarded the Kabwe and the Saldanha people as

examples of African Neanderthalians that differed from the European. Wells (1957) proposed that Kabwe man represented a regionally-differentiated derivative from a basic *Homo sapiens* stock, which in turn had risen directly from a primitive Pithecanthropine stock. Arambourg (1963) and Coon (1963) classify both the Rhodesian and Saldanha specimens as Pithecanthropines. Recently, Stringer (1974b)has shown that there are some similarities between the Kabwe and Petralona skulls. Opinions have differed regarding the classification of Kabwe man. It is now widely accepted that Neanderthal and Neanderthaloid forms are sub-species of *Homo sapiens* (Campbell, 1964 and Rightmire, 1975). The above view has been challenged by Santa Luca (1978) who gave the opinion that a skull to be classified as "Neanderthal-like" must have some distinctive Neanderthal features. According to him, Kabwe man has none of the necessary diagnostic traits.

The absolute dating of the Kabwe skull has been very difficult. However, on the faunal, archaeological and chemical evidences, it seemed that the Kabwe man lived during the Upper Pleistocene, possibly about 40,000 years B.P. Recently, a revised date of the Kabwe site, on the basis of the artifacts and fauna, has been suggested to be 125,000 years B.P. (Klein, 1973). Bada et al., (1974) has suggested a preliminary age of 110,000 years B.P. on the basis of amino-acid racemisation of the hominid bones from the site.

2. The Singa skull (Sudan)

The Singa calvaria was discovered in 1924 by W.G.R. Bond, at Singa District, west bank of the Blue Nile (Oakley et al., 1977). The calvaria was found eroding from a caliche deposit within the Gezira clay. This deposit is mainly of a limestone concretion. Associated with the Singa calvaria were faunal and archaeological remains. The archaeological remains have been described by Lacaille (1951) as being of Middle Stone Age, Proto-Stillbay industry of Lochard, Rhodesia. Marks (1968) however, cautioned that the artifacts were non-descript and not necessarily of the same age. The faunal association has been described by Bate (1951) as belonging to the Upper Pleistocene age. It includes, *Crocodylus niloticus*, *Hystrix astasobae* and *Homoioceras singae*.

The Singa calvaria was first described by Woodward (1938) who considered the specimen to be a variant of the Boskop type of *Homo sapiens* known from the later Pleistocene of the southern Africa. Similar conclusions were drawn by Wells (1951) after a series of comparisons with a wider range of Upper Pleistocene hominids. Briggs (1955), in addition to the pre-Bushman affinities, suggested the resemblance of the Singa calvaria to the crania from the late Pleistocene/Holocene site of Afalou in Algeria. This view was discounted by Anderson (1968) who emphasised the links of the Afalou crania with the European Upper Palaeolithic and Mesolithic populations. Tobias (1968) noted that the supposed

Bushmanoid features of the Singa calvaria were only restricted to the rear of the vault, while the front part was more archaic, and even resembling the Broken Hill cranium. In an intensive study of the calvaria Brothwell (1974) concluded that the overall cranial morphology of the Singa calvaria was closer to early Upper Pleistocene crania from Europe, Asia and Africa and suggested that the Singa fossil might represent a hybrid of Neanderthaloid and anatomically modern populations. However, Rightmire (1975) sees no closeness of the Singa calvaria to the Neanderthaloid nor to the proto-Bushman or Bushman material from southern Africa, and agrees with Wells (1972) that it might be related to the Omo (Kibish) material. Recently, Stringer (1979) has concluded that the Singa calvaria is an unusual archaic *Homo sapiens* fossil, perhaps closely related to the crania from Dbjel Irhoud.

The stratigraphical age of the Singa calvaria is said to be of the Upper Pleistocene period. Absolute dating by C^{14} dating methods on a fossil crocodile tooth from Abu Hugar is estimated to be 17,000 yr. B.P. (Oakley et al., 1977).

3. The Florisbad skull (South Africa)

The Florisbad site is about 40 km north-west of Bloemfontein, Orange Free State, Republic of South Africa (Oakley et al., 1977). The skull was discovered in 1932 by T.F. Dreyer in a spring eye and consists of a facio-calvarial fragment.

The site of the discovery is marked by numerous springs, many of which have become choked with accumulated debris. Dreyer (1935) described the debris to consist of sand containing stone artifacts, broken bones and teeth. The heavier sand is ilmenite with garnets and diopside, whilst above it, there is a cap of pure white quartz sand. Presently, the site is known to consist of eleven strata including a basal layer and four other layers of peat. The skull was found in the lowest of four peat layers, Peat I.

The archaeological association of the skull was first described by Dreyer (1935) to consist of stone tools of African Middle Stone Age industry, probably resembling the Hagenstadt variation (Oakley, 1954). The associated mammalian fauna have been described by Cooke (1964) to consist of several living rodents and carnivores as well as extinct species such as giant buffalo (*Connochaetes antiquus, Alcelaphus helmei*) and *Equus helmei* and *Equus burchelli*.

The antiquity of the Florisbad skull has caused much discussion in the past. In his original article Dreyer (1935) named the skull as *Homo (Africanthropus) helmei*, sub-generically distinct from other members of the genus *Homo*. In the same publication, Kappers, after the study of the endocranial cast, emphasised its likeness to that of *Homo sapiens*. However, Drennan (1935, 1937) regarded it as representing an African Neanderthal variant

and proposed the name *Homo florisbadensis helmei* as being more appropriate. This view was opposed by Galloway (1937, 1938) who emphasised the *Homo sapiens* likeness of the skull, when considering the non-metrical features. Similar views were given by Boule and Vallois (1957) who regarded the skull to belong to *Homo sapiens*. Recently, Rightmire (1978) has compared the Florisbad skull with other sub-Saharan African hominid remains from Kabwe, the Omo and Klasies River Mouth.

The dating of the Florisbad skull has been a problem. From cultural association, the deposits belong to the Upper Pleistocene or even the Holocene. The lowest of the four peat layers, Peat I, has been given C^{14} dates of 41,000 yrs, 35,000 yrs and 44,000 yrs (Barendsen, Deevey and Gralenski, 1957). Bakker (1957) and Oakley (1957) have cautioned that fossil carbon from the coal beds below may have been carried upwards by the spring water, so giving a false antiquity to the layer as a whole. New relative dating of the Florisbad skull has been given by Protsch (1975) as being 38,680 $\pm$ 2,000 yrs on the basis of C^{14} dating of the fauna.

4. The Saldanha skull (South Africa)

The site of the discovery was at Elandsfontein farm, near Hopefield, 24 km south-east of Saldanha Bay, Cape Province (Oakley et al., 1977). The Saldanha skull was discovered by Jolly and Singer in 1953 and consists of 27

skull bone pieces that fit together when reconstructed. The skull bone pieces were picked up from the site on several visits. Initially only 11 pieces were recovered, while the other pieces including a portion of the mandible were recovered later.

For a very long time after the recovery of the Saldanha hominid remains, there has been some doubt as to their stratigraphic occurrence, and cultural and faunal association. However, excavations by the Chicago expedition of 1965-66 (Singer and Wymer, 1968) together with the detailed geological studies, first by Mabbutt (1956) and more recently by Butzer (1973), seem to have clarified the issues. It is now believed that there is a stratigraphical division of the industries within the sand (Singer and Wymer 1968). The hominid remains were found on the surface of the sandy veld, 300 feet above sea level. The fossil horizon is made from nodular calcrete representing a dried-out plan-floor in which bones had accumulated. Ridges of ferricrete cut across the site and indicated previous wetter conditions, but the fossil layer is capped by surface limestones produced during drought (Mabbut, 1956 and 1957).

The recovered artifacts consist of three types of stone tools (Singer 1954; Singer and Crawford, 1958). The Early Stone Age (final Acheulian or modified Fauresmith) tools lie on the ancient surface and include cleavers, large and pygmy hand-axes, pebble chopper and unconventional

tools; all made of silicate, quartzite, felspar or soft sandstone. The skull bone pieces were associated with this culture. The Middle Stone Age tools (Stillbay) and the Late Stone Age tools are derived from higher levels.

The faunal assemblage includes *Loxodonta atlantica, Papio ursus, Simopithecus sp. Diceros bicornis, Ceratotherium simum, Equus plicatus, Mesocheroerus lategani* and *Hippopotaus amphibius*. This fauna is frequently compared with the faunal assemblages recovered from the Younger Gravel Complex, lower Vaal River Basin (Wells 1964), the Cornelia area of the upper Vaal drainage (Butzer, Clark and Cook 1974) and that from Olduvai Bed IV. If this is correct, it would tend to support an older age for the Elandsfontein fauna of late Middle Pleistocene rather than an early Upper Pleistocene as formerly believed.

For a long time after the recovery of the Saldanha skull its similarity with the Rhodesian skull has been expressed by most workers like Drennan (1953 a and b), and Singer (1954). Singer (1954) described the Saldanha and the Rhodesian skulls as representing an African Neanderthal form different in many respects from the classic European type and resembling to some extent the larger specimens of the Asiatic Neanderthal from Ngandong. Presently, both the Saldanha and the Rhodesian skulls are regarded as sub-species of *Homo sapiens rhodesiensis* (Campbell 1964; Howell 1978).

The dating of the Saldanha skull remains uncertain; however, on the geological, archaeological and faunal evidence, the site is attributed to the late Middle Pleistocene.

5. Djebel Ighoud (Morocco)

Two homind skulls identified as Djebel Ighoud 1 and 2 were recovered in the Djebel Ighoud barytes mine about 60 km south-east of Safi, Morocco (Oakley et al., 1977). The Djebel Ighoud 1 skull was discovered by workmen in 1961 and has been investigated by E. Ennouchi (1962a). The Djebel Ighoud 2 skull was discovered by workmen and E. Ennouchi (1968).

The Djebel Ighoud skulls were found in fissure-filling deposits within the Pre-Cambrian limestone of the barytes mine and were associated with numerous flint industry attributed to the Levalloiso-Mousterian culture together with an Upper Pleistocene fauna. The faunal remains included, *Gazella atlantica*, *Gazella cuvieri*, *Gazella dorcas*, *Rhinoceros sp.*, *Equus mauritanicus*, *Canis anthus* and *Alcelaphus bubalis* (Ennouchi, 1962b).

According to Ennouchi (1962b), the Djebel Ighoud skulls fall within the range of variation for the Neanderthal group and show similarities to the La Chapelle and La Ferrassie skulls. This view was not fully accepted by Piveteau (1967) or Howells (1974), both

stressing the more modern features of the skulls. However, Stringer (1974a) after an intensive multivariate analysis, concluded that the Djebel Ighoud skulls showed close similarities to the Amud, Skhul 5 and Saccopastore skulls.

In the present study, it is shown that the Djebel Ighoud 1 skull is closer to the La Chapelle, La Ferrassie, Amud I and Tabūn I skulls. This finding seems to support the original opinion that the Djebel Ighoud skulls are more closely related to the classic Neanderthalers than to the more modern *Homo sapiens*.

The dating of the Djebel Ighoud skulls has been based on faunal and cultural associations. As such the site has been attributed to the Middle Pleistocene (Ennouchi, 1963).

C. HOMINID FOSSIL CRANIA FROM THE LATE MIDDLE AND UPPER PLEISTOCENE OF THE MIDDLE EAST

1. The Tabūn and Skhūl Remains (Israel; Mount Carmel)

A joint expedition of the British School of Archaeology in Jerusalem and the American School of Prehistoric Research, directed by D.A.E. Garrod (1929-1934) excavated the caves Mugharet et-Tabūn and Mugharet es-Skhūl. The two caves are situated on the western slope of Mount Carmel, south-east of Haifa, Israel (Oakley et al., 1975). The human remains have been described in a lengthy monograph by McCown and Keith (1939).

The western slope of Mount Carmel at Wadi el-Mughara is penetrated by a number of caves which are hollowed into a steep limestone escarpment. Excavations at Mugharet et-Tabūn cave yielded the human remains consisting of a female skeleton, a male mandible as well as other fragmentary hominid bones. A number of archaeological layers lettered A-G from above were recognised during the excavation and contained numerous implements. The human remains were associated with the Levalloiso-Mousterian culture, together with abundant fauna that included, *Hippopotamus amphibius, Sus gadarensis, Cervus elaphus, Dama dama mesopotamica, Bos sp., Gazella sp.*, as well as *Equus hemionus*.

Excavations at the Mugharet es-Skhūl also disclosed a number of hominid bones belonging to at least ten individuals believed to be deliberately buried. Several archaeological layers containing flint implements were also recognised. The flint implements have been attributed to the Levalloiso-Mousterian culture similar to that of the Tabūn cave. The mammalian faunal remains were also similar to those found at the Tabūn cave.

Originally McCown and Keith (1939) believed that the Tabūn and the Skhūl remains belonged to two distinct peoples. From their study, the two authors Garrod and Bate, concluded that the remains represented a single population of one species or race on the basis of the dental features, cultural association and being found at the same contemporaneous

locality, (Garrod and Bate, 1937). Nonetheless, the Skhūl remains possessed a mixture of traits, some Neanderthal and others of more recent *Homo sapiens* character. Subsequent authors were divided between the extreme variability and hybridization as possible suggestions for the materials. McCown and Keith rejected the hybridity theory as there were no other known finds within the vicinity. Authors such as Coon (1939), Montagu (1940), Thoma (1957-1958 and 1965) were in favour of the hybridization theory while Stewart, (1951) and Brothwell (1961) were of the opinion that there were two different populations, which did not inhabit the caves contemporaneously and may have lived thousands of years apart. Higgs (1961) cast doubt on the dating of the Skhūl remains while Brothwell (1961), discussing the dating of the remains, concluded that the human remains broadly belonged to two populations, an earlier Palestinian Neanderthal population represented by Tabūn and a more advanced population represented by Skhūl. This concept has so far been widely accepted by a number of authors and is supported by the evidence of the Djebel Kafzeh remains which are similar to the Skhūl remains, and the remains from Gallilee and Shanidar believed to resemble the Tabūn material.

The ages of the Tabūn and Skhūl remains have not been determined certainly. Originally, Garrod and Bate (1937) believed that the two sites were contemporaneous and suggested that they might belong to the end of the

Last Interglacial. Higgs (1961), after a comparative study of a number of Mediterranean coastal sites, concluded that the Skhūl site might be younger than the Tabūn site by 10,000 years. Garrod (1962) has suggested a radio-carbon date of 45,000 ± 2,000 years B.P. for Tabūn layer C, a date within the first part of the Würm Glaciation. Vogel and Waterbolk (1963) have given a radio-carbon date of 40,000 years B.P. ± 1,000 years for level C, the hominid layer for Tabūn I.

D. HOMINID FOSSIL CRANIA FROM THE LATE MIDDLE AND UPPER PLEISTOCENE IN THE FAR EAST/AUSTRALIA

1. The Wadjak I and II skulls (Indonesia)

The site of the discovery lies near Tulungagung, Central Java, Indonesia (Oakley et al., 1975). The Wadjak skulls were discovered by B.D. van Rietschoten, 1889 (Wadjak I), and by E. Dubois, 1890 (Wadjak II). The skulls were first described by Dubois (1921).

The Wadjak skulls comprise of: a nearly complete skull and a broken mandible (Wadjak I); a broken skull with nearly complete mandible (Wadjak II). Both skulls are large, heavily mineralised and dolicephalic. In the original description Dubois (1922) considered Wadjak I to be female, whilst Wadjak II to be male. Morphologically, Wadjak I skull presents with a keeled cranial vault, receding forehead, prominent superciliary ridges and low orbits; the occiput is protuberant tending towards

the formation of a bun. The facial skeleton shows depression of the nose and flattening of the nasal bones. The maxillae present with a marked degree of alveolar prognathism. Wadjak II skull though is larger than Wadjak I, presents with almost similar morphological features.

In his description of the skulls, Dubois (1922) noted some Australoid features in the Wadjak man, nevertheless he assigned a new species of *Homo wadjakensis*. Subsequent assessment (Pinkley, 1936) identified Wadjak man with *Homo sapiens*. Presently, it is widely accepted that the Wadjak man has the Australoid affinities.

The Wadjak man was found cemented in a limestone breccia terrace near an ancient lake (Dubois, 1922). There were no artifacts associated with the skulls but faunal remains similar to that found in modern Java were recovered. The dating of the Wadjak man has been based on this faunal association and on the degree of mineralisation of the skulls. A late Upper Pleistocene or early Holocene date has been suggested (Dubois, 1922).

2. The Pekin skulls

The skulls from China were recovered between 1928 and 1936 from a cave in Locality I, near the village of Choukoutien 25 miles south-west of Peking (Oakley et al., 1975).

The Choukoutien hominid fossil crania all came from a cave site, Locality I, though one maxillary fragment was found in the Upper Cave, whose formation exposed the deposits of Locality I (Oakley et al., 1975). Locality I was originally a large cave, part of a system of fissures in Ordovician limestone, whose roof collapsed upon the cave sediments (Oakley et al., 1975). After further sedimentation, the whole formation became consolidated, forming in parts a stalagmitic breccia. The principal site was at a cliff face 150 ft. deep consisting of cave fillings and collapsed cavern. It was in this cave filling at various levels that the Pekin man was found.

Various names have been assigned to the Pekin man. Initially Davidson Black (1927) gave the name *Sinanthropus pekinensis*, to the hominid molar tooth first discovered. With subsequent discoveries the name was retained for the other finds, but soon afterwards the resemblances between *Pithecanthropus* and *Sinanthropus* began to become clear (Boule, 1929). After a detailed study of the Pekin crania (Weidenreich, 1936, 1937, 1940 and 1941) took the view that the differences between the *Pithecanthropus* and *Sinanthropus* were of a racial character only. It has been suggested that Pekin man, in company with several other Middle Pleistocene hominids should be classified under the name of *Homo erectus* (Mayr, 1950) and given the geographic subspecific designation *pekinensis*. This proposal has been incorporated in a recent classification (Campbell, 1964).

Associated with the Pekin man were a number of artifacts attributed to a crude Chopper-tool industry, made from imported coarse-grained quartz and greenstone (Black et al., 1933). Numerous mammalian bones that include, *Canis*, *Gulo gulo*, *Hyena*, *Megaceros*, *Apodemus* and *Microtus* were recovered with the Pekin man (Kahlke, 1962).

The dating of the Choukoutien remains has been difficult. However, on the basis of fauna, the site has been attributed to Middle Pleistocene. Kurtén (1959) suggested that the dating equivalent of the Choukoutien deposits should be sought in the European glaciation and not in an interglacial. In his view, the deposits are within the Second Glaciation (Elster II or the Antepenultimate Glaciation).

3. Ngandong (Solo River)

Excavations conducted by the Java Geological Survey between 1931 and 1933, at Ngandong, six miles north of Ngawi Central Java, Indonesia, unearthed about eleven individuals consisting of eleven calvaria and two tibiae (Oakley et al., 1975). Seven of the crania were regarded as being adult on the ground of sutural fusion (Weidenreich, 1951) and of these, two were believed to be male, two female and the remainder of indeterminate sex.

The affinities of the Solo crania have been of much discussion amongst the earlier workers. Oppenoorth

(1932a) originally assigned the calvariae to the genus *Homo* and a sub-genus *Javanthropus*. In later publications, (Oppenoorth, 1932b, 1937) the name was dropped and that of *Homo soloensis* was proposed. Weidenreich (1933) proposed the name *Homo primigenus asiaticus* as a part of a wider scheme of hominid classification. Vallois (1935), suggested that the Solo people were simply a local variety of Neanderthal and criticized the creation of a sub-genus. Soon after this there followed a protracted controversy between Dubois and von Koenigswald regarding the relationships of the Java finds; Dubois (1936) at first proclaimed the 'racial identity' of Solo man, Modjokerto man and Peking man, but later believed that Solo man was identical with Wadjak man and thus a form of *Homo sapiens* (Dubois, 1940). However, von Koenigswald had indicated his belief in the Neanderthal affinities of this form by naming it *Homo neanderthalensis soloensis* (von Koenigswald, 1934). Finally Weidenreich (1951) in an unfinished paper examined all the Solo material in considerable detail; he contented himself by stating that Ngandong man is not a true Neanderthal type but distinctly more primitive and very close to *Pithecanthropus* and *Sinanthropus*. Nonetheless, von Koenigswald has adhered to his view that Solo man is a primitive 'tropical Neanderthaler' (von Koenigswald, 1958). In a recent classification of the Hominidae (Campbell, 1964), it has been proposed to include Solo man as a sub-species of *Homo sapiens (Homo sapiens soloensis)* distinct from modern man *(H. sap. sapiens)*, Neanderthal man

(H. sap. neanderthalensis) and Rhodesian man *(H. sap. rhodesiensis)*.

The Solo skulls were discovered from Ngandong terrace (von Koenigswald, 1951). Three gravel terraces have been recognised at the valley of the river Solo and include, gravel terrace at two metres, seven metres and 20 metres. The Solo finds were uncovered in the 20-metre terrace, above the Kabul beds. Only a few stone implements of the indeterminate industry were associated with the Solo remains, but there were numerous faunal remains including, *Cervus javanicus, Sus terhaari, Sus macrognathus, Rhinoceros sondaicus, Hexaprotodon ngandongensis* etc.

The dating of the Solo remains has been based on the stratigraphy and faunal association, the Ngandong deposits have been suggested to be of Upper Pleistocene date (von Koenigswald, 1949).

4. Kow Swamp (Australia)

The site of the discovery lies at Lunette, NE perimeter of Kow Swamp (Oakley et al., 1975).

The first discovery at the Kow Swamp site was made between 1967 and 1968 when a highly mineralised and carbonate encrusted partial skeleton was unearthed (Thorne and Macumber, 1972). Subsequent excavations at the Kow Swamp site has yielded remains of at least 40 individuals. These remains have so far been studied (Thorne, 1971;

Thorne and Macumber, 1972 and Thorne and Wilson, 1977) and are of late Pleistocene period. The Kow Swamp displays a complex of morphologically archaic features. Thus, the crania are large and dolicephalic, with thick vault bone and well developed muscle insertions (Thorne and Macumber, 1972).

All of the skeletal material at Kow Swamp was excavated from primary burials that are abundant at the site. Most of the material was found in shallow burials and within relatively soft lacustrine and aeolian sediments (Thorne and Macumber, 1972). Geologically, the Kow Swamp site lies on the Riverine Plain in Victoria, astride a major flow path of the ancestral Murray River system and its tributaries. At present, the Kow Swamp is largely an artificial reservoir occupying the depression of an earlier late Quaternary lake formed in a back levee position of the ancient Mead Stream. Around the eastern edge of the swamp is a narrow belt of lacustrine silts (Cohuna Silt), about 0.25 km wide and only 1 m thick. The Cohuna Silt is in part overlain by Kow Sand which forms a low crescentic dune (lunette), rising to a height of about 4 m above the plain. The skeletal material occurs in both the Cuhuna and Silt and Kow Sand (Thorne and Macumber, 1972).

Associated with the skeletal material were stone artefacts, ochre, shells and marsupial teeth. More than 50 quartz artefacts, many of them carbonate encrusted, have also been recovered (Thorne and Macumber, 1972).

Radiocarbon dating on charcoal and bone at the Kow Swamp site has given an estimated age of about 10,000 yrs B.P. (Thorne and Macumber, 1972).

E. HOMINID FOSSIL CRANIA IN THE LATE MIDDLE AND UPPER PLEISTOCENE IN EUROPE

1. La Chapelle-aux-Saints (France)

The site of the discovery lies near the village of La Chapelle-aux-Saints, 25 miles south-east of Brieve, Correze, France (Oakley et al., 1971). The human skeleton from this site was discovered and reported in 1908 by A. and J. Bouyssonie and L. Bardon. The detailed description of the skeleton itself was written by Boule (1911-1913).

The stratigraphy of the site of the discovery was carefully recorded during the excavation process and the skeleton was found in a small shallow grave hollowed into limestone deposits of the Lower Lias, which rests upon Triassic sandstone. The human skeleton was covered with calcareous clay containing stones which had fallen from the roof. Associated with the skeleton were numerous flint tools of an evolved Mousterian culture. The associated mammalian fauna includes, *Coelodonta antiquitatis, Rangifer tarandus, Bison priscus* and *canis lupus*.

The dating of the La Chapelle-aux-Saints site has not yet been ascertained precisely. However, it has recently been shown, ApSimon (1980), that a number of

well-known neanderthal finds, including Le Moustier, La Chapelle-aux-Saints, La Ferrassie and La Quina, date from the later sub-stage (Wurm II).

2. La Ferrassie (France)

The rock shelter at La Ferrassie, north of Bogue, Dordogne, France has yielded the remains of six individuals. The site was excavated by R. Capitan and D. Peyrony between 1909 and 1921. The human remains include an adult male, one adult female, three infants and one foetus. These were initially partly described by Boule (1911-1913); recently, an extensive report has been given by Heim (1968, 1970 and 1974).

The stratigraphical level of the site of the discovery was determined by a team of French pre-historians who ascertained that the level was clearly the same as that of La Chapelle-aux-Saints. The skeletons were recovered below three Perigordian layers, four Aurignacian levels and one Chattelperonian layer at the bottom of a layer containing Mousterian tools; this in turn rested upon another layer containing Acheulean implements. The associated artefacts are attributed to Charentian Mousterian culture (Bourgin, 1957) while the faunal remains consisted of *Mammuth primigenius*, *Crocuta crocuta*, *Cervus elephas* and *Equus sp*.

The La Ferrassie remains like those of the La Chapelle-aux-Saints, ApSimon (1980), may date from the later sub-stage (Wurm II).

3. Steinheim (Germany)

The site of the discovery was at Sigrist gravel pit, Steinheim on the river Murr, about 12 miles north of Stuttgart, Wurttemberg, West Germany (Oakley et al., 1971). The Steinheim calvaria was discovered by Karl Sigrist in 1933 and was unearthed by F. Berckhemer. It is a damaged calvaria.

The calvaria was recovered from the Pleistocene deposits overlain by a layer of loess. Several distinct strata of sands and gravels have been identified at the Sigrist pit. The strata of sands and gravels, together with the mammalian fauna have been studied by Berckhemer (1925) and others who demonstrated that the gravels are of two types and contain two separate faunal groups. However, Adam (1954a and b) demonstrated that four layers of the gravels can be distinguished, each with its characteristic fauna. This view was reaffirmed by Howell (1960). The Older Mammoth Gravel layer is at the bottom and contains *Mammuthus trogontherii*, whilst above this is the Straight-tusked Elephant Gravels containing *Palaeoloxodon antiquus*. The human calvaria was recovered from this layer. Above it is the Main Mammoth Gravels with *Mammuthus trogontherii-primigenius* and is overlain by Younger Mammoth Gravels

containing *Mammuthus primigenius*. No artefacts have been recovered from the Steinheim gravels.

The Steinheim specimen has not been fully described so far. A preliminary report was published by Berckhemer (1933) and Weinert (1946) published a longer report. However, the Steinheim specimen shows some resemblances with the Neanderthalers in the supra-orbital torus development and in having a broad nasal opening. The morphology of the posterior portion of the cranium resembles that of the Swanscombe individual attributed to *Homo sapiens*.

In view of the stratigraphical and faunal evidences, the Steinheim remains have been attributed to the Second Interglacial period (Great, Mindel-Riss or Penultimate Interglacial); this has been reaffirmed by Kurten (1962) and Oakley (1964).

4. Swanscombe (United Kingdom)

The site of the discovery was at Barnfield pit, about half a mile south-west of All Saints Church, Swanscombe, Kent (Oakley et al., 1971).

The Swanscombe skull bones were discovered by A.T. Marston, 29 June 1935 and March 1936; Mr. and Mrs. B.O. Wymer, A. Gibson and J. Wymer, 30 July 1955. The skull bones consist of an occipital (1935), a left parietal (1936) and a right parietal (1955). These are all well preserved and articulate together perfectly.

The Swanscombe skull bones are of much interest and well known. The occipital and the left parietal bones were first studied by the Swanscombe committee (Morant et al., 1938). In their report, Morant from his extensive biometric study insisted on the modern characters of the two bones. There were however, certain distinctive features from *Homo sapiens* including the basibregmatic height and the biasterionic breadth that were indeed much greater. Morant thought that the fore part of the skull might have been massively developed and that the skull was similar to the Steinheim and the two might represent the same human population. This view was supported by Breitinger (1952 and 1955) after comparative analysis of form and measurements of the two skulls. Vallois (1954) however, was not in favour of the above view and pointed out that there were distinctions between the Swanscombe and the Steinheim skulls with the latter appearing more archaic. Moreover, there was no evidence suggestive of a large brow ridge in the Swanscombe skull. Vallois regards the Swanscombe and Fontechevade as 'Presapiens' forms evolving parallel with Steinheim-Neanderthal line. The similarities between Swanscombe and Steinheim were again pointed out by Clark (1955).

The Swanscombe site and fossil material has been thoroughly reinvestigated recently (Brothwell et al., 1964). Weiner and Campbell (1964) following a morphological, metrical and statistical analyses of the skull bones of the Swanscombe, regarded the skull as belonging to the

Neanderthaloid 'intermediate' group which contains the Steinheim, Erhringsdorf, Skhül V and Krapiana specimens.

The skull bones were recovered at a depth of 24 feet at the base of the Upper Middle Gravel of the 100-foot terrace of the Thames. Associated with the skull bones were numerous hand-axes and flakes of Middle Acheulian culture (Breuil, Acheulean III) and an extensive mammalian fauna that include *Dama clactoniana, Dicerorhinus kirchbergensis, Cervus elephas* and *Palaeoloxodon antiquus*. These are all derived from a warm temperate fauna indicating an interglacial period.

On the basis of the geological and faunal evidences, the Swanscombe deposits date from the close of the Second Interglacial (Mindel-Riss or Penultimate Interglacial). The skull fragments and the associated fauna are contemporaneous as revealed by fluorine dating method (Oakley, 1949). The Second Interglacial date of the Swanscombe fragments has been reaffirmed by Kurten (1962), Oakley (1964) and Szabo and Collins (1975).

5. Vértesszöllös Remains (Hungary)

The site of the discovery is near the village of Vértesszöllös about 50 km to the west of Budapest, Hungary (Oakley et al., 1971). The excavations at the site were undertaken by the Hungarian National Museum team led by Dr. Laslo Vertes in 1964 and 1965. The team recovered two

groups of human remains identified as Vértesszöllös I (1964), consisting of several fragments of decidous teeth from the lower dentition of a child and Vértesszöllös II (1965), consisting of two fragments of an adult occipital bone.

The human remains were excavated in a quarry cut into the travertine deposits of the terrace of the Danube system which consists of four occupational layers. It was the lowest level (Level I) that contained the human remains. Associated with the human remains were abundant artefacts consisting of pebble-tools and chopper-tools together with small sized flakes attributed to Bada Industry (Kretzoi and Vertes, 1965). The mammalian faunal remains included *Trogontherium schmerlingi*, *Didermocerus etruscus* and *Canis etruscus*.

The Vértesszöllös remains have been extensively studied by Thoma (1966, 1967 and 1969). From the morphological comparisons together with metrical analysis, Thoma (1966) came to the conclusion that the Vértesszöllös remains originated from *Homo erectus* but differentiated to occupy a progressive line represented by Swanscombe, Fontechevade and Quinzano. Wolpoff (1971a and b), on the other hand, takes the view that the teeth and the occipital bone together should be allocated to *Homo erectus*.

The human remains have been dated to a warm phase within the Second Glaciation (Mindel or Elster Glaciations) on the stratigraphical evidence and the presence of imprints

of beech leaves from the lower layers. The Thorium/Uranium estimates of the travertines has given a date of 350,000 years B.P. (Cherdyntsev, Kazachevsky and Kuzmina, 1965).

III. MATERIALS

The materials used in this study are discussed in two parts as follows:

A. Anatomical Description of the Laetoli Hominid 18 Cranium.

B. Comparative materials.

The anatomical terminology adopted in this thesis is adherent to Gray's Anatomy, Descriptive and Applied (1973).

A. ANATOMICAL DESCRIPTION OF THE LAETOLI HOMINID 18 CRANIUM

(a) The cranium as a whole

In its present condition, the Laetoli Hominid 18 cranium consists of an almost complete and intact cranial vault, much of the base together with both temporal bones and a part of the sphenoid bone. The maxillo-facial fragment including part of the upper dentition is only partially preserved and completely detached from the rest of the cranium. There is no mandible preserved. The cranium is large, long and oval-shaped with a low cranial vault. The individual fossil bones are all heavily mineralized and are yellowish-grey in colour like most of the bones of the same geological source. The bones show no signs of pathology but do show signs of minimal surface erosion in particular the temporal bones. Also, the bones of the supraorbital region and the left

temporal do show signs of post-mortem plastic deformation that resulted in torsion to the right of the supraorbital region and in some springing of the temporo-occipital suture on the left. All the principal sutures are still open and well preserved. The bregma, lambda and asterion are well defined. Internally, most of the endocranial features are well retained.

(i) <u>The Exterior of the Laetoli Hominid 18 Cranium</u>

When viewed in norma frontalis (Plates 2A and B) the frontal region is nearly complete and intact. The supraorbital region is twisted to the right side. The frontal view of the Laetoli Hominid 18 cranium reveals several striking features; the developed and divided supraorbital torus, the lowness of the vault, the slight keeling of the frontal bone in the sagittal plane and the prominence of the mid-parietal bossing. The glabella is moderately developed and below it and at the same vertical plane is the nasion.

In norma lateralis (Plates 3A and B; 4A and B) further striking features of the Laetoli Hominid 18 cranium are revealed, the most outstanding of which are the recession of the frontal region, the presence of a shallow ophryonic sulcus on either side of the midline, the roundness of the occipital profile with a prominent occipital torus, the smallness of the mastoid processes and the presence of a well developed occipitomastoid crest (only preserved on the right side).

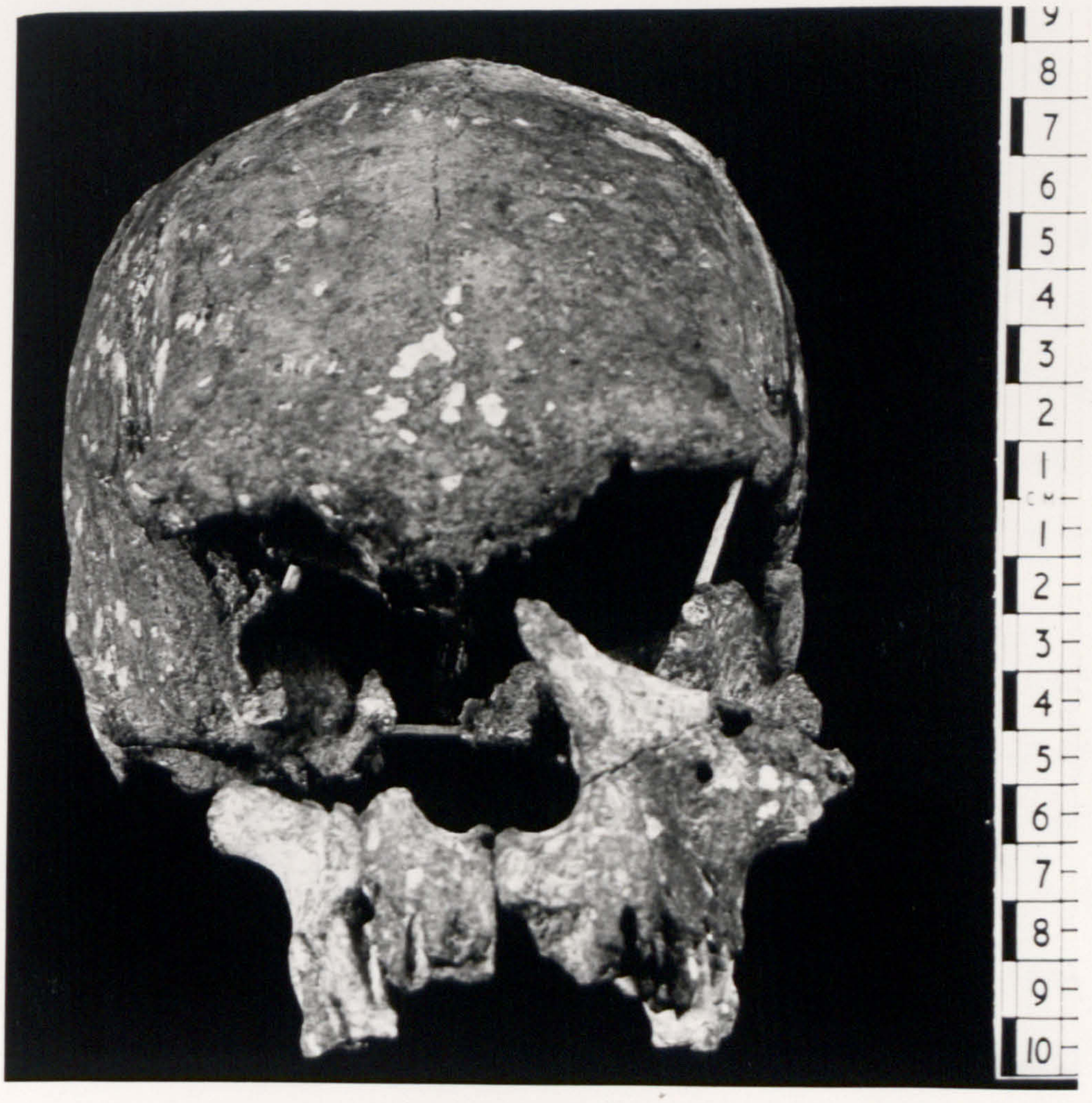


PLATE 2A: Norma frontalis of the Laetoli Hominid 18 cranium before cleaning. Note the adherent matrix on the bone surface obscuring its detailed anatomical features.

PLATE 2B: Norma frontalis of the Laetoli Hominid 18 cranium after cleaning. Note, the morphology of the surface of the bone by the cleaning, the frontal bone is almost complete, the glabella and the supraorbital torus are developed, the torus is clearly divisible into two parts (a lateral trigonum supraorbitale and a medial superciliary ridge). The supraorbital notches are preserved on both sides, the position of the nasion is well indicated. The facial bones are completely detached from the rest of the cranium; on the left side, only a small portion of the frontal process of the maxilla is missing for the articulation with the frontal bone, the nasal aperture is pear-shaped and the infra-orbital foramen is preserved on the left side.

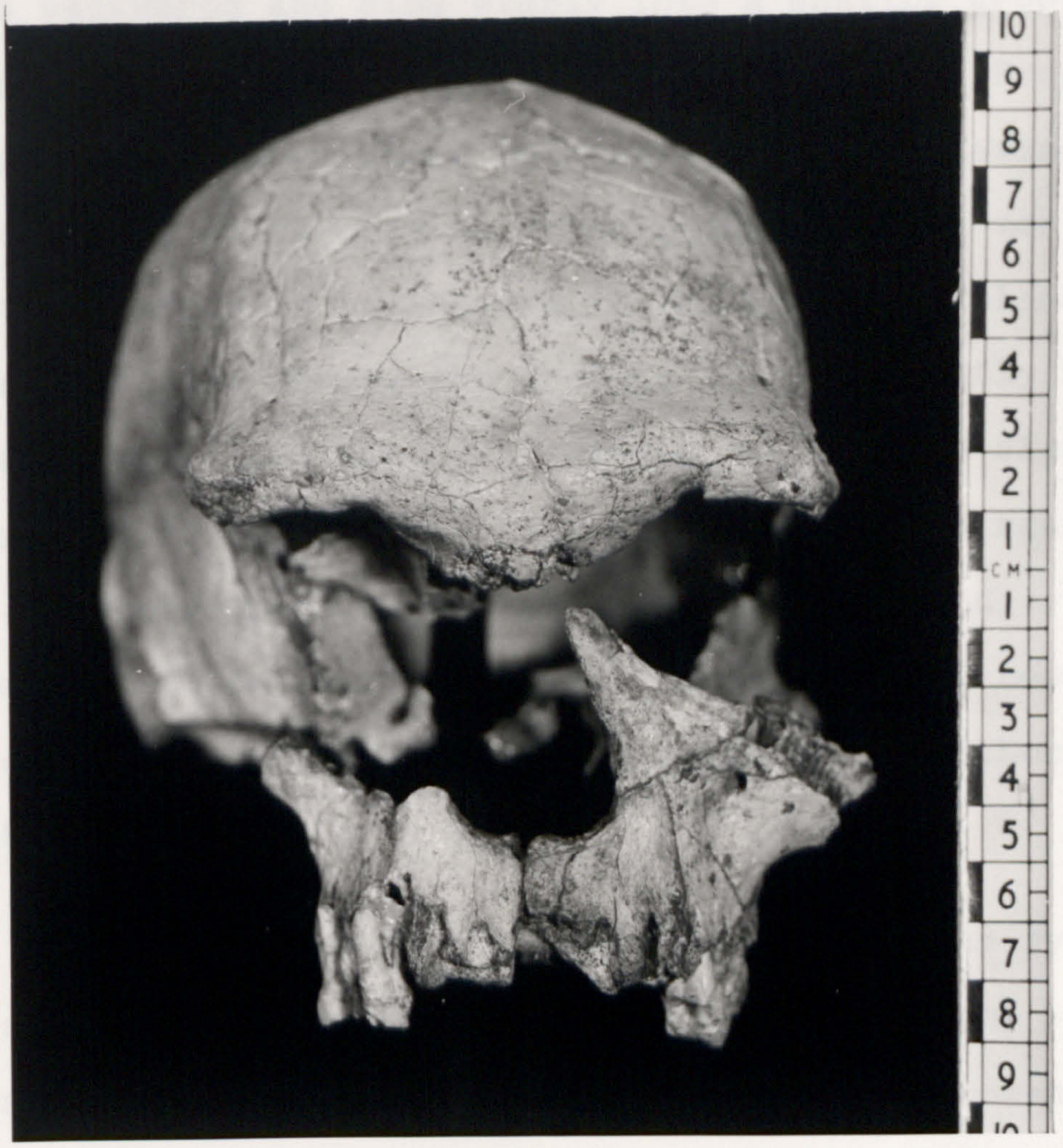


PLATE 2B

The cranial vault is well displayed. Thus, from the region of the glabella the outline of the vault slopes backwards and dips evenly into a shallow groove, the ophryonic sulcus at the supratoral surface. From this point the curve rises smoothly reaching a maximum at the bregma which appears to coincide with the vertex when the cranium is orientated in the Frankfurt plane. Posterior to the bregma the profile proceeds gently to the mid-parietal region then it flattens for a short distance posteriorly to the lambda. The curve then rises again to trace a rounded profile of the occipital bone and terminates at the inion. Due to the bulging and roundness of the occipital profile, the inion and the opisthocranium do not coincide.

On both sides of the cranium, most of the zygomatic process of the frontal bone as well as part of the lateral portion of the supraorbital torus are broken off. The superior temporal line is represented by a conspicuous crest. Anteriorly, the superior temporal crest runs from the broken edge of the zygomatic process of the frontal bone and sweeps across the bone to the coronal suture. On the left side, the course of the crest is interrupted due to bone deficiency of the frontal bone around this region. From the coronal suture the superior temporal crest curves further posteriorly to the parietal eminence from where it continues for a short distance posteriorly and fades away before it reappears and then forms the supramastoid crest. The supramastoid crest

PLATE 3A: Right norma lateralis of the Laetoli Hominid 18 cranium before cleaning. Note the adherent matrix on the bone surface obscuring its detailed anatomical features.

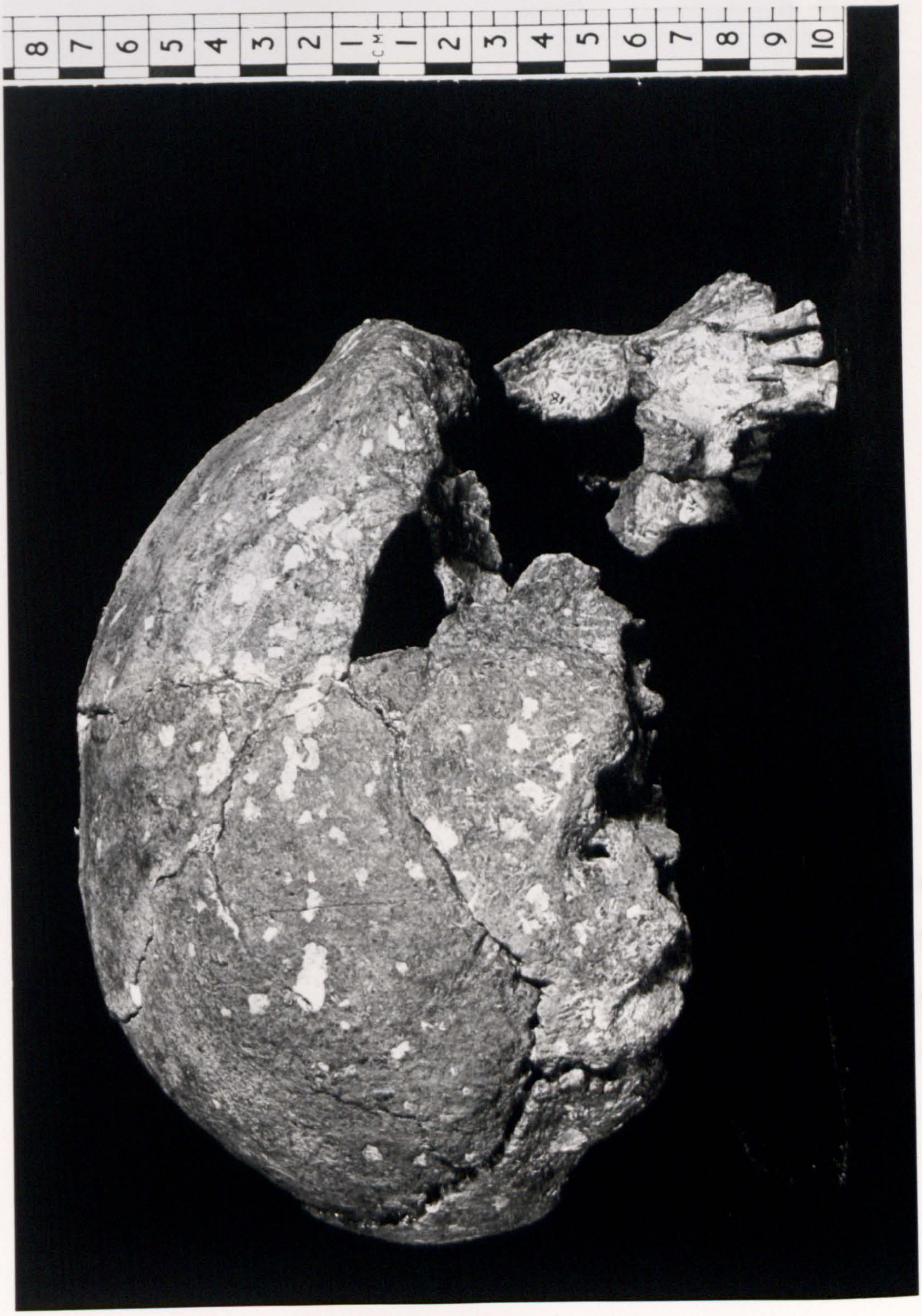


PLATE 3A

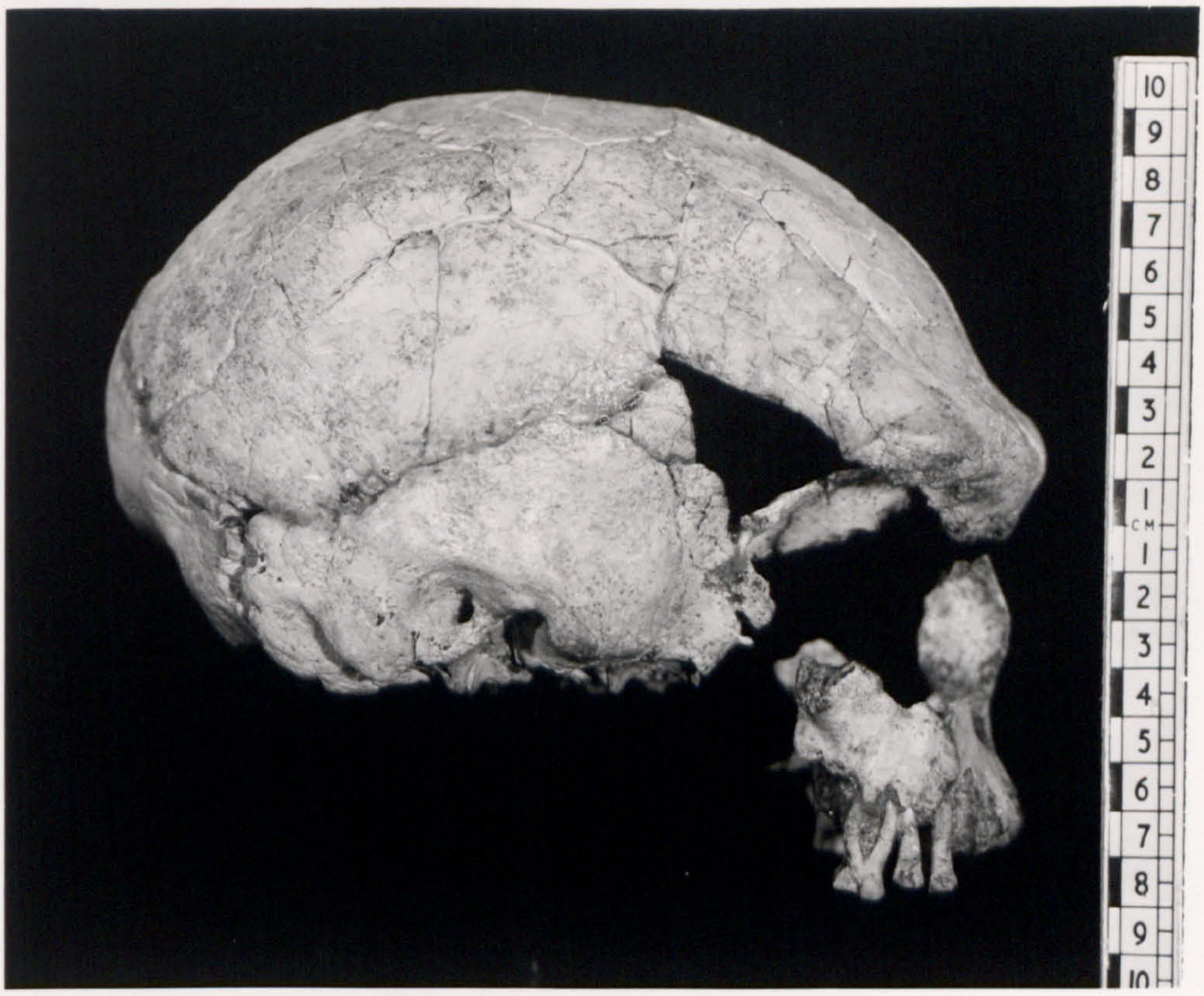


PLATE 3B: Right norma lateralis of the Laetoli Hominid 18 cranium after cleaning. Note the recession of the frontal bone, the presence of a shallow ophryonic groove, the low set of the cranial vault, the roundness of the occipital region, the developed occipital torus, the low set of the right temporal bone, the smallness of the mastoid process and the marked developed occipitomastoid crest.

PLATE 4A: Left norma lateralis of the Laetoli Hominid 18 cranium before cleaning. Note the adherent matrix on the bone surface obscuring its detailed anatomical features.

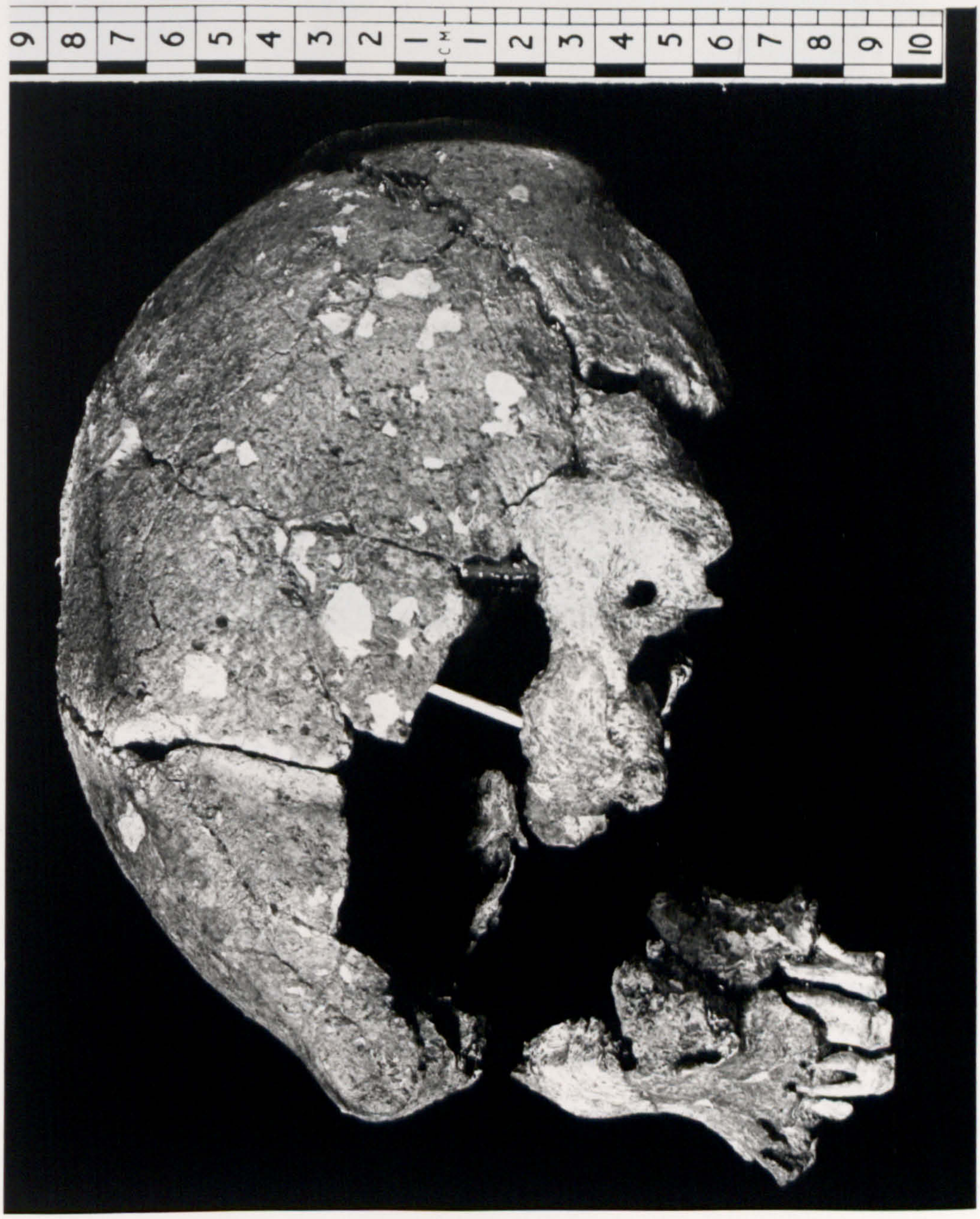


PLATE 4A

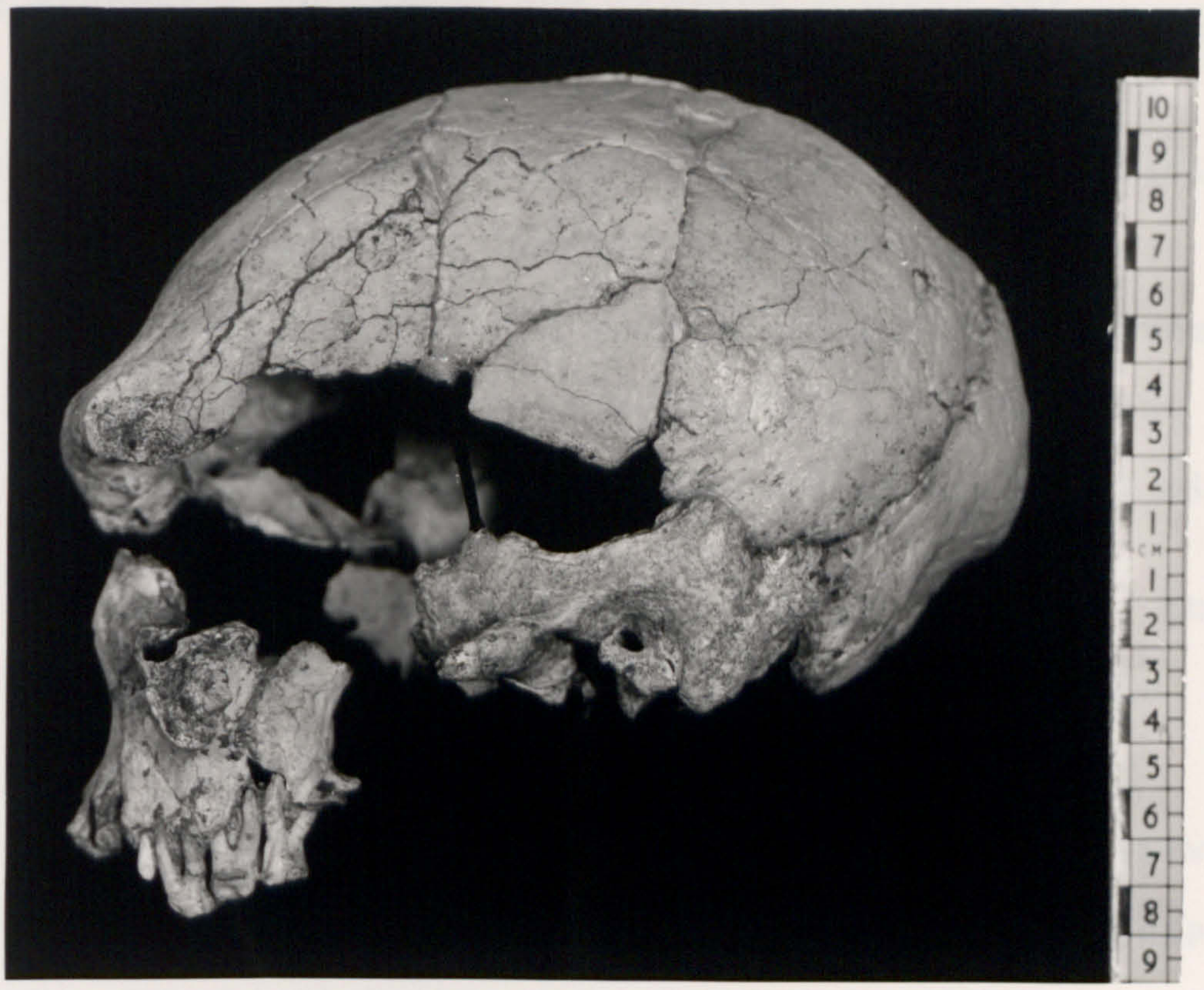


PLATE 4B: Left norma lateralis of the Laetoli Hominid 18 cranium after cleaning. Note, the low set of the cranial vault, the recession of the frontal region, the shallow ophryonic groove, the roundness of the occipital region and the developed occipital torus, the low set of the left temporal bone and the smallness of the mastoid process.

is well marked and is continuous with the posterior root of the zygomatic process of the temporal bone. Both zygomatic processes are largely sheared off. The position of the suprameatal triangle can well be located and there is no suprameatal spine. The mastoid processes are small and limited both medially and posteriorly by deep mastoid notches (digastric grooves). The mastoid notches are bounded medially by prominent occipitomastoid crests (only preserved on the right side).

Seen in norma occipitalis (Plates 5A and B) the cranium shows an almost symmetrical appearance. The cranium is well rounded with flexed nuchal plane. The mid-parietal bossing is more apparent in this view. The external surface of the squamous part of the occipital bone is clearly divisible into an upper convex supra-occipital and a lower nuchal part by a prominent occipital torus. The occipital torus is centrally situated and of a uniform thickness in the vertical plane. Laterally, and inferiorly, the torus fades away and does not become continuous with the supramastoid crest. The precise position of the external occipital protuberance is ill-defined. The nuchal portion of the squamous part of the occipital bone is slightly flexed anteriorly and limited by a prominent occipitomastoid crest laterally. Centrally, the nuchal portion is divided by a well marked external occipital crest that separates two shallow depressions for the attachments of the nuchal muscles.

Viewed from norma verticalis (Plates 6A and B) the

PLATE 5A: Norma occipitalis of the Laetoli Hominid 18 cranium before cleaning. Note, the adherent matrix on the bone surface obscuring its detailed anatomical features.

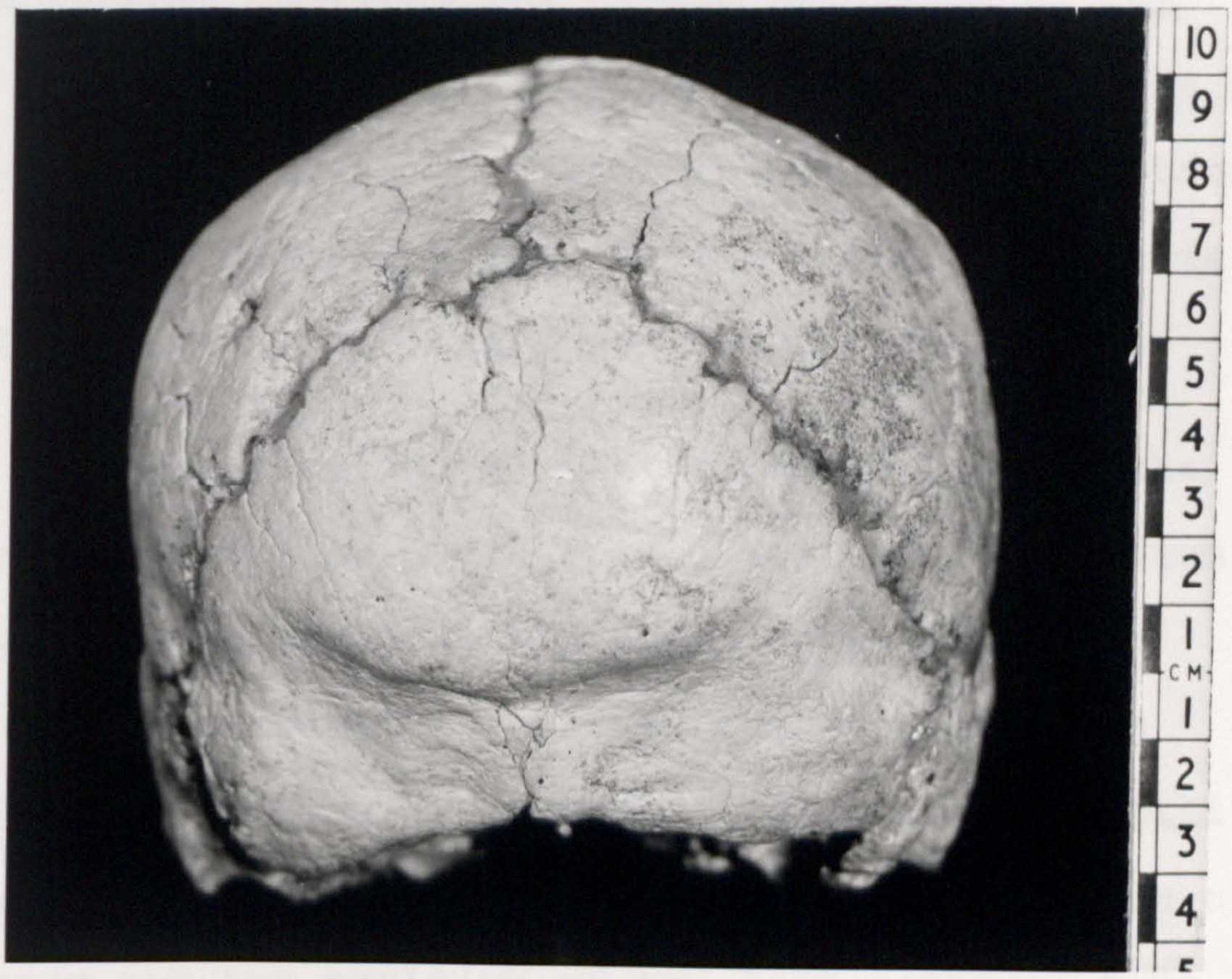


PLATE 5B: Norma occipitalis of the Laetoli Hominid 18 cranium after cleaning. Note, the roundness of the occipital region, the mid-parietal bossing and the developed occipital torus.

calvaria is complete, elongated and oval shaped with a slight twist to the right of the supraorbital region. The view further confirms the marked recession of the frontal bone, the prominence of the supraorbital torus and the mid-parietal expansion. The coronal and the lambdoid sutures as well as the positions of the lambda and bregma are well revealed. There are no parietal foramina.

In norma basalis (Plates 7A and B) most of the anterior and posterior parts of the base of the cranium are missing. The specimen has been broken along the line of the frontonasal suture and thus exposing two medium sized frontal air sinuses. The basal view still confirms the deformation affecting the frontal region of the cranium and the position of the left temporal bone.

The orbital roof is only partially preserved on both sides. On the right side a part of the roof together with part of the articulation of the frontal with the ethmoid is preserved. The ethmoid bone is represented by part of its labyrinth (lateral mass). The bone clearly shows the outline of the ethmoidal air cells together with the positions of the anterior and posterior ethmoidal canals.

The sphenoid bone is partially preserved. Most of its body is missing. On the right side, the sphenoid bone is represented by part of the body, greater wing and part of the lesser wing. On the left side, only a small part of the body together with a small part of the greater wing of the sphenoid bone are preserved. The positions of the

PLATE 6A: Norma verticalis of the Laetoli Hominid 18 cranium before cleaning. Note, the adherent matrix on the bone surface obscuring its detailed anatomical features.

PLATE 6B: Norma verticalis of the Laetoli Hominid 18 cranium after cleaning. Note, the completeness of the calvaria, the elongation of the calvaria, the well preserved coronal and lambdoidal sutures as well as the positions of the bregma and lambda, the mid-parietal bossing.

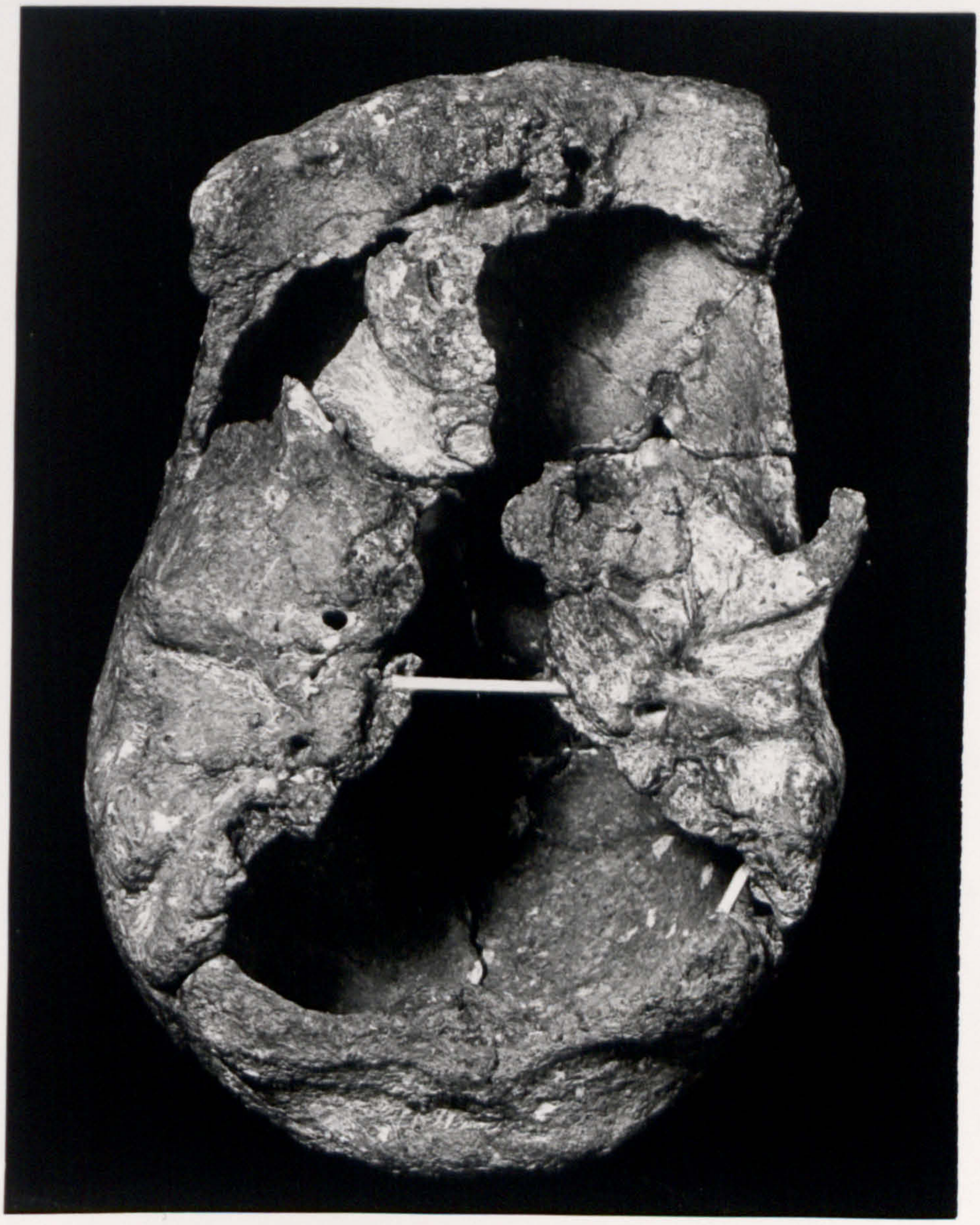


PLATE 7A: Norma basalis of the Laetoli Hominid 18 cranium before cleaning. Note, the adherent matrix on the bone surface obscuring its detailed anatomical features.

PLATE 7B: Norma basalis of the Laetoli Hominid 18 cranium after cleaning. Note, the specimen has been broken along the line of the frontonasal suture exposing two medium-sized frontal air sinuses, the ethmoidal air sinuses, the greater wing of the sphenoid bone on the right side, the positions of the foramen ovale and foramen spinosum on the right side, the root of the zygomatic processes together with the glenoid fossa.

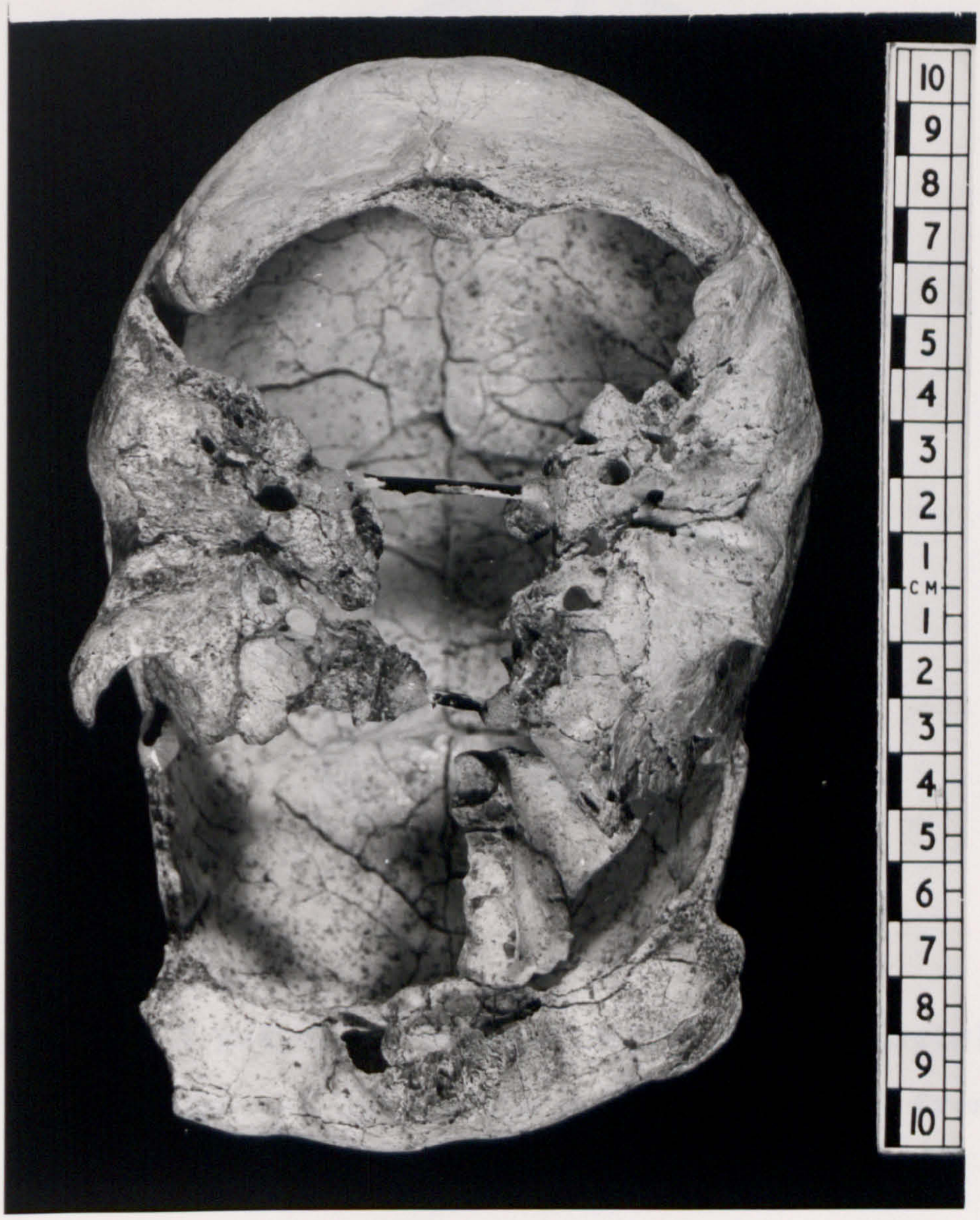


PLATE 7B

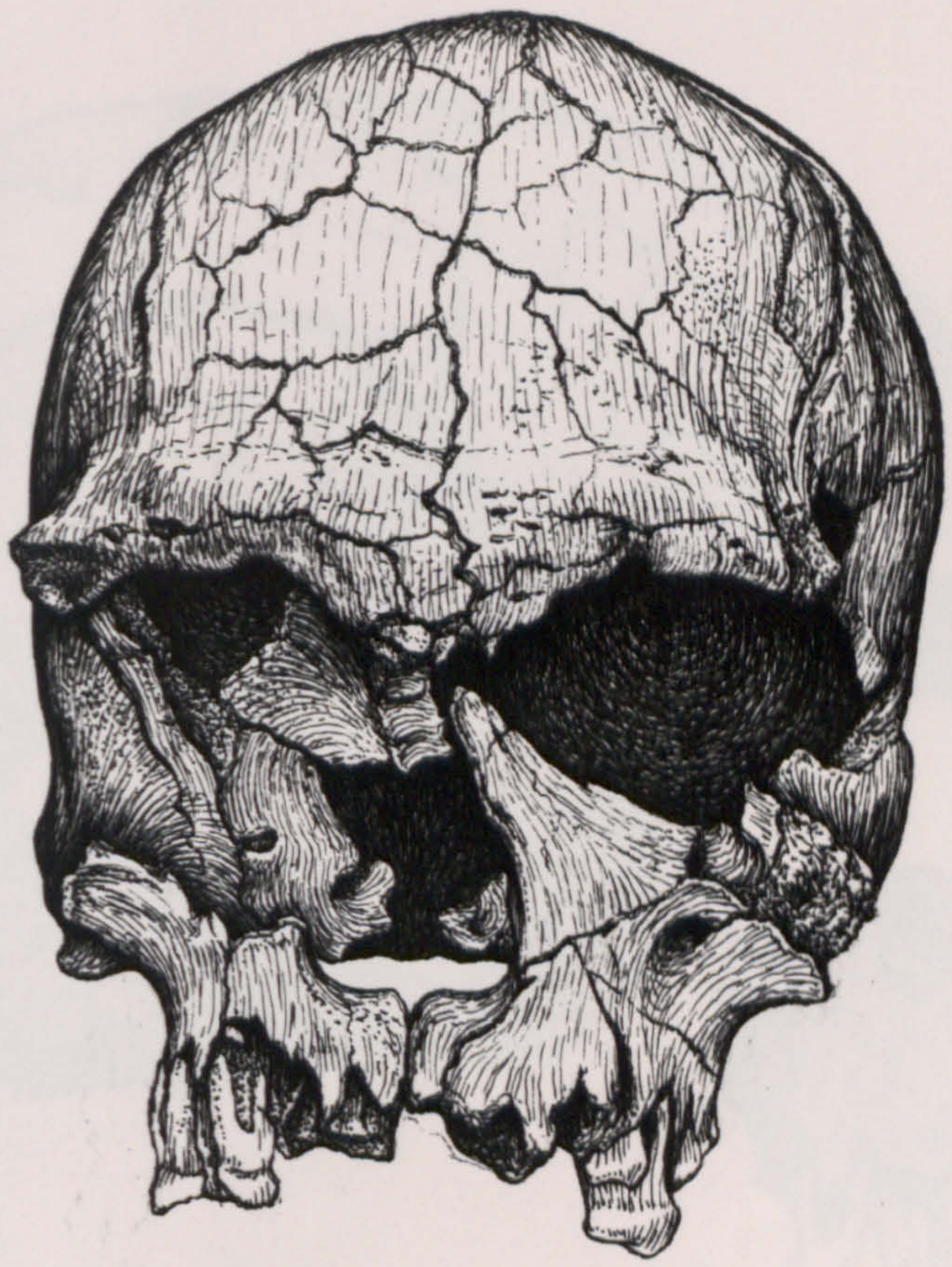


FIGURE 1A: A graphical reconstruction of the Laetoli Hominid 18 cranium as seen from the front.

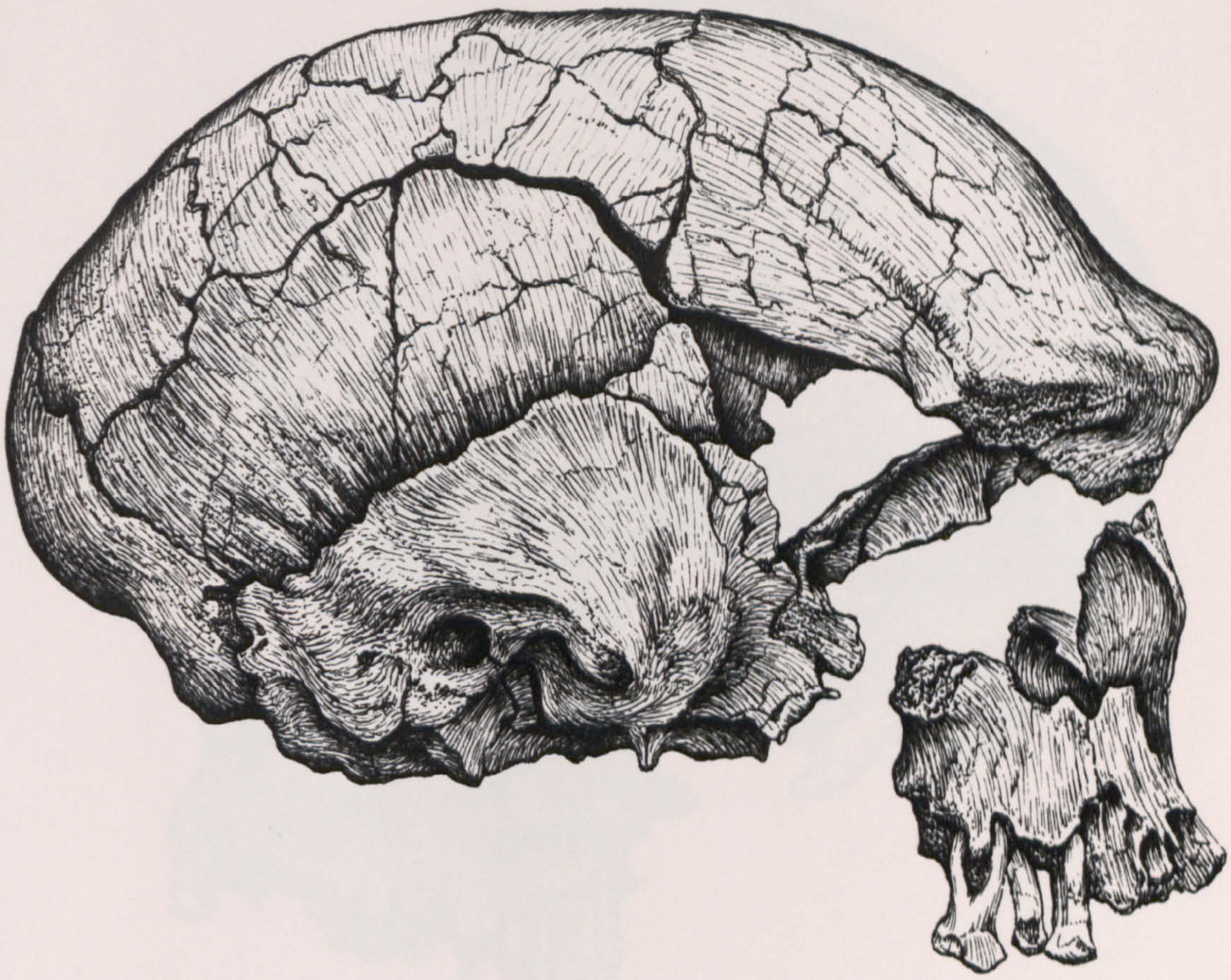


FIGURE 1B: A graphical reconstruction of the Laetoli Hominid 18 cranium as seen from the right norma lateralis.

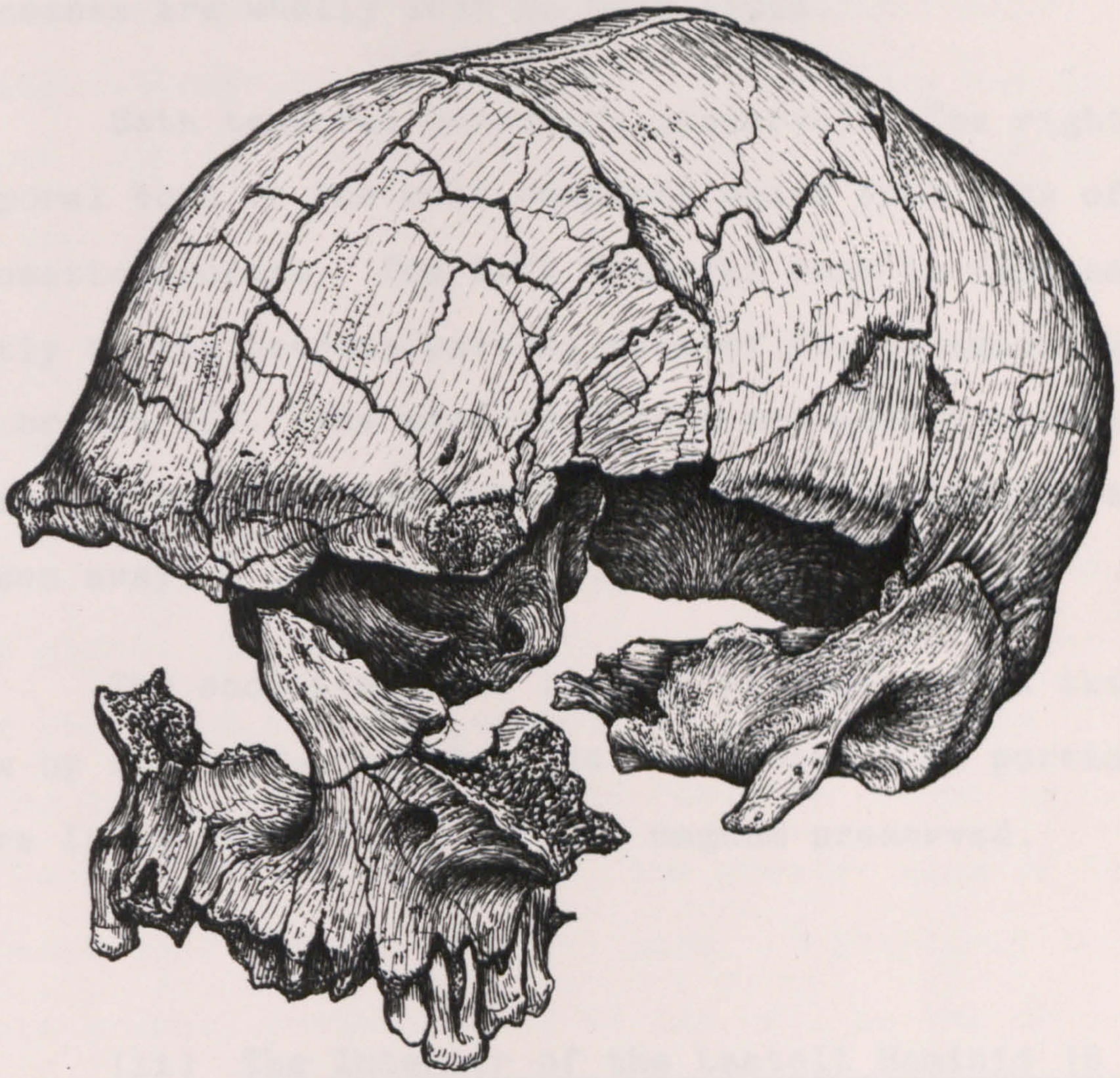


FIGURE 1C: A graphical reconstruction of the Laetoli Hominid 18 cranium, ¾ view.

foramen ovale and foarmen spinosum are clearly indicated on both sides of the cranium. The pterygoid processes are wholly lost on both sides.

Both temporal bones are preserved. The right temporal bone is the most complete apart from loss of the zygomatic process. The left temporal bone is represented mostly by its petrous part as much of its squamous part has broken off. The glenoid fossae are almost completely preserved on both sides while the styloid processes are broken away.

The occipital bone is only represented in this view by its post-occipital and supra-occipital portions. There is no part of the foramen magnum preserved.

(ii) <u>The Interior of the Laetoli Hominid 18 Cranium</u>

The cranial cavity of the Laetoli Hominid 18 is only partially preserved. The inner aspect of the calvaria is the best preserved part and consists of an almost complete and intact surface. Moderately marked grooves for the cerebral hemisphere can be seen on this inner surface. The groove for the superior sagittal sinus is ill-defined anteriorly but becomes more conspicuous posteriorly on the occipital bone at the region of the internal occipital protuberance where on the right side it directly joins with the groove for the transverse venous sinus. There are no depressions for arachnoid granulations

along the course of the superior sagittal sinus groove. On the lateral walls of the temporal and parietal bones are several grooves for the branches of the middle meningeal vessels. These grooves are shallow and can be traced running upwards and backwards on the surfaces of the bones.

The interior of the base of the cranium is only preserved in parts. Most of the bones forming the anterior cranial fossa are missing and only a small portion of the orbital part of the frontal bone is preserved on both sides. The middle cranial fossa is well preserved on both sides and is more complete on the right side than on the left. On both sides the fossa is formed by part of the body of the sphenoid bone, the greater wing of the sphenoid bone and the temporal bone. Posteriorly the middle cranial fossa extends as far back as the superior border of the petrous part of the temporal bone. On the superior border of the temporal bone on both sides can be seen grooves for the superior petrosal sinus. Also in the fossa the lateral depressions for the temporal lobe of the brain are well preserved. The position of the foramen lacerum and the opening for the internal carotid canal are ill-defined due to some bone deficiency and to the intensive surface erosion affecting this area. The openings for the foramen ovale as well as of the foramen spinosum are clearly defined on both sides. On the right side a part of the lower border of the superior orbital fissure and the opening for the optic foramen are preserved.

The posterior cranial fossa is partially preserved. The fossa is mainly made by the posterior surface of the petrous part of the temporal bone and a portion of the post-occipital part of the squamous portion of the occipital bone. On both sides, on the inferior surface of the petrous part of the temporal bone, there is a small oval shaped aperture for the opening of the internal auditory meatus. Passing laterally on each side of the internal occipital protuberance and running transversally then curving downward on the inner aspect of the petro-mastoid part of the temporal bone, is a shallow groove for the transverse and sigmoid sinuses. Only a part of the internal occipital crest is preserved and runs upwards from the broken edge of the post-occiput to the internal occipital protuberance. On each side of the internal occipital crest is a deep hollow depression for the cerebellar hemisphere.

(b) <u>The disarticulated bones of the Laetoli Hominid 18 cranium</u>

(i) <u>The frontal bone</u>

The frontal bone is largely intact and almost complete. The bone has been restored from two fragments that have been glued together. On both sides, most of the zygomatic processes of the frontal bone together with those parts forming the nasal, temporal and orbital surfaces are missing. The coronal margin is well preserved

and intact. Anteriorly, both supraorbital margins are incomplete and lack in their lateral ends. The frontal bone is heavily mineralized and shows signs of post-mortem plastic deformation that has resulted in torsion to the right of the supraorbital region. There are no signs of pathology and none of surface erosion affecting this bone.

The outer surface of the frontal bone (Plate 8) is markedly flattened (platycephalic) with slight keeling in the midline. The surface above the supraorbital region presents with a shallow ophryonic sulcus on either side of the midline. There are no obvious frontal eminences. As a whole, the frontal surface is smooth though interrupted by several small shallow cracks. One of the cracks cuts across the whole length of the bone in the midline position and extends from the nasion to the coronal margin posteriorly.

The supraorbital region on both sides, is prominent, non-confluent and divisible into three distinct elements; the supraorbital margin, the superciliary ridge or arcus superciliaris and the trigonum supraorbitale. Both supraorbital margins are incomplete and lack their lateral portions. The margins form in an arch like manner and extend from the broken articular surface of the frontomaxillary suture medially to the broken edge of the zygomatic process of the frontal bone laterally. Both margins have well defined borders which are crossed by deep supraorbital notches. The superciliary ridge or

arcus superciliaris is well preserved on both sides. It is complete, semilunar shaped with elevated smooth outer surface. Its inner end curves downwards into the less prominent glabella and is separated from the corresponding eminence of the opposite side by a shallow median depression. The outer end of the superciliary ridge sweeps laterally but fades away as it approaches the trigonum supraorbitale. It is separated from the latter by an ill defined and obliquely running shallow groove, more marked on the right side. On both sides, only part of the trigonum supraorbitale is preserved.

The glabella is only moderately developed. Its outer surface is smooth and contains a shallow depression in the midline. The nasion is well below and in the same vertical plane as the glabella.

The frontal bone is broken off in the region of the nasion and thus exposes two frontal air sinuses between the outer and inner tables of the frontal bone. The frontal air sinuses are oval shaped and of medium size. Laterally the sinuses extend into the orbital roof and their cavities can be seen to be divided into intercommunicating recesses by incomplete bony partitions.

On both sides of the frontal bone, the lateral surface is broken off and is separated from the frontal surface by a conspicuous superior temporal crest. The crest runs from the broken edge of the zygomatic process of the frontal bone, and then sweeps across the whole length

PLATE 8: External surface of the frontal bone of the Laetoli Hominid 18 cranium. Note, the frontal bone is almost complete, the coronal sutural margin is intact, cracks revealed by the development and cleaning are still cemented by matrix, both zygomatic processes of the frontal bone are broken, the glabella together with the supraorbital torus are developed, the supraorbital margins are almost complete and a supraorbital foramen can be seen on the right side of the bone.

of the bone on to the parietal bone.

The orbital surface of the frontal bone is partially preserved on both sides. On the right side part of the orbital roof as well as part of the articulation of the frontal with the ethmoid is preserved. On the left side only a small concave part of the orbital roof is preserved.

The inner surface of the frontal bone (Plate 9) is concave and like the outer surface, the inner surface is also smooth though marked by the convolutions of the cerebral hemispheres and interrupted by small cracks. The grooves for the meningeal vessels are not conspicuous and there are no depressions for the Pacchionian bodies seen. In the midline the inner surface of the frontal bone presents with an internal median crest that extends from the mid-frontal region and ends below just a short distance before reaching the cribriform plate of the ethmoid bone. The foramen caecum is not preserved.

(ii) <u>The parietal bones</u>

Both parietal bones are preserved and almost complete.

<u>The right parietal bone</u>:

The right parietal bone is complete with well preserved borders and angles. The bone is restored from three separate pieces that fit each other. The right parietal bone is rectangular and like the frontal bone is

PLATE 9: Internal surface of the frontal bone of the Laetoli Hominid 18 cranium. Note, the internal surface is concave and smooth though interrupted by cracks revealed by the development and cleaning, the internal median crest extends from the mid-frontal region and ends below just a short distance before reaching the cribriforn plate of the ethmoid bone; the foramen caecum is not preserved. The orbital plates are broken away; two frontal air sinuses between the outer and inner tables of the frontal bone are revealed, the frontal air sinuses are oval shaped and of medium size, they extend laterally into the orbital roof.

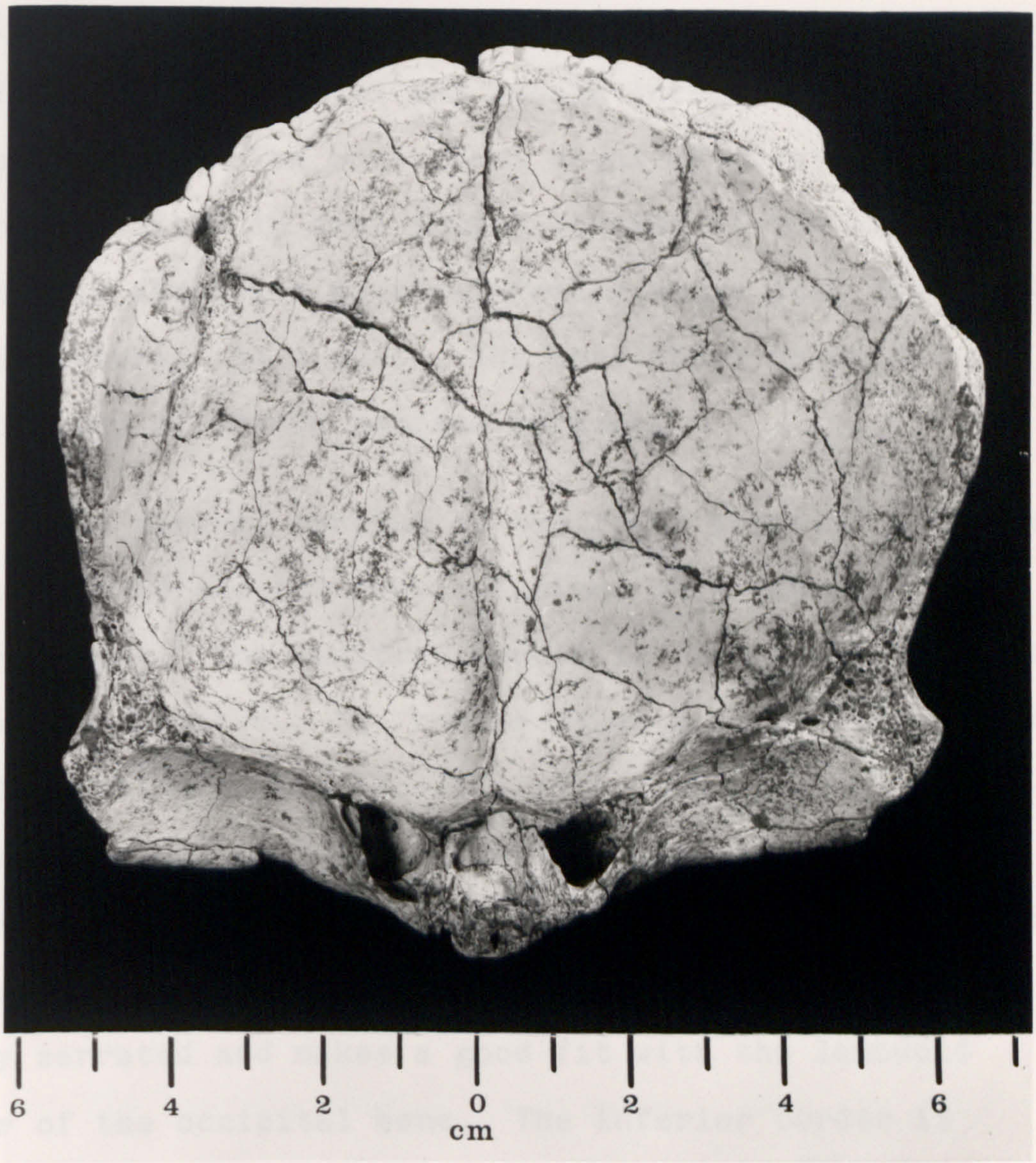


PLATE 9

thick walled. The bone is more thickened along its sagittal and lambdoid borders and is thin along its inferior border. The outer surface of the right parietal bone (Plate 10) is convex and smooth though interrupted by small cracks. The bone shows signs of plastic deformation that has resulted in some inward torsion of the area immediately above the antero-inferior angle just behind the coronal suture. As a whole, the bone shows no pathology and no signs of severe surface erosion.

The sutural margins of the right parietal bone are well preserved and the denticulations show remarkably little damage. The sagittal border is rather straight and moderately serrated. The border makes a good articulation with its fellow of the opposite side. The coronal border, like the sagittal border, is also less serrated and similarly makes a good contact with the coronal margin of the frontal bone. Posteriorly, the lambdoid border is deeply serrated and makes a good fit with the lambdoid border of the occipital bone. The inferior border is short, sharp and curved. The border is obliquely bevelled and makes a nice fit at the squamosal suture.

From the excellent state of preservation of the sutural margins, it is quite certain that no fusion had occurred along these lines.

The outer surface of the right parietal bone is slightly flattened anteriorly and superiorly around the anterosuperior and posterosuperior angles respectively.

PLATE 10: External surface of the right parietal bone of the Laetoli Hominid 18 cranium. Note the completeness of the right parietal bone, the matrix filled cracks, the sagittal border is rather straight and moderately serrated, the coronal border like the sagittal is also moderately serrated while the lambdoid border is deeply serrated, the inferior border is short, sharp and obliquely bevelled.

In general, the external contour of the bone is rounded from side to side and displays prominent mid-parietal bossing. There are no parietal foramina to be seen.

The superior temporal crest is low set and continues from the frontal bone anteriorly. Just behind the coronal suture, the course of the superior temporal crest is ill-marked but it becomes more conspicuous as it curves along the mid-parietal bossing. Posterior to the parietal bossing the temporal crest continues for a short distance before fading away. Thus, from the marking of the superior temporal crest it may be inferred that the temporal muscles were only moderately developed in this individual.

The inner surface of the right parietal bone (Plate 1 1) is intact, concave and with a marked parietal fossa. The inner surface clearly displays impressions for the gyri of the right cerebral hemisphere and vascular grooves for the branches of the middle meningeal vessels (Fig. 2). Two main vascular grooves are displayed on the inner surface, one of which starts from the antero-inferior angle and the other from the postero-inferior and run upwards and backwards giving out smaller branches as they do so. The grooves fade away as they approach the sagittal border. Along the sagittal border at the mid-parietal region only a partial and ill-defined shallow groove for the superior sagittal sinus can be seen. There are no obvious depressions for the Pacchionian bodies.

PLATE 11: Internal surface of the right parietal bone of the Laetoli Hominid 18 cranium. Note, the completeness of the inner surface, the surface is concave and with a marked parietal fossa, the bone is thick, the sagittal and the lambdoid sutural margins are serrated, the inner surface displays vascular grooves for the branches of the right middle meningeal vessels.

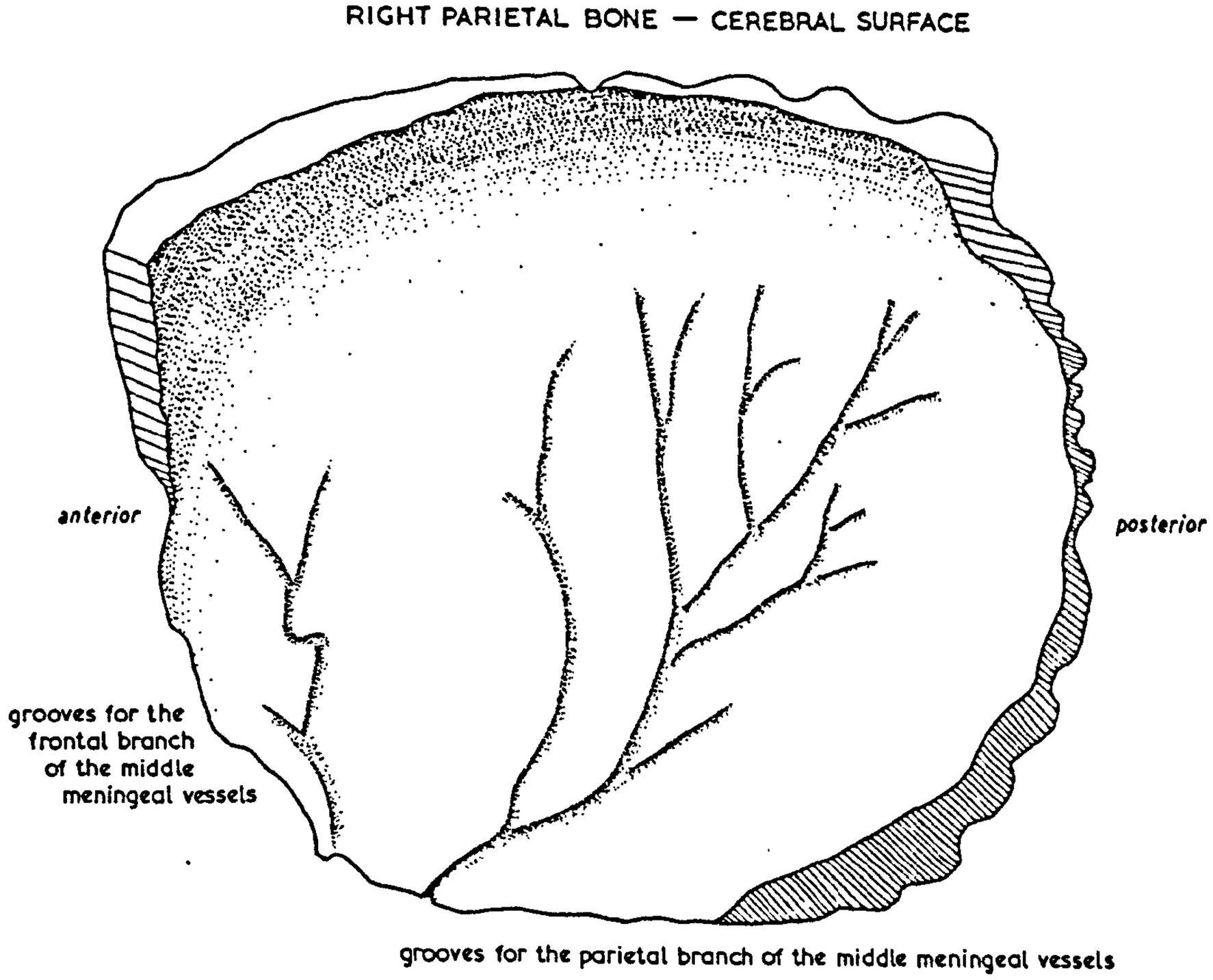


FIGURE 2: A graphical reconstruction of the vascular grooves for the branches of the right middle meningeal vessels of the Laetoli Hominid 18 cranium. Note, the two main branches of the vascular grooves, one for the frontal branch of the right middle meningeal vessels and the other for the parietal branch of the right middle meningeal vessels. Basically, the two main vascular grooves start from the antero-inferior angle of the right parietal bone and run upwards and backwards giving out smaller branches as they do so. The grooves fade away as they approach the sagittal border.

The left parietal bone:

The left parietal bone is restored from four separate pieces of bone that fit each other nicely. Unlike the right parietal, the left parietal bone is incomplete and lacks most of its antero-inferior border. Like the right parietal, the left parietal bone is also rectangular shaped, thick walled and with similar external contours. Posteriorly, at about 14 mm from the lambdoid border, the outer surface of the left parietal bone (Plate 12) presents with an even rounded depression of about 10 mm in diameter. From the external outline of the depression and from the evidence afforded from the X-ray, it is suggested that the feature is self-limiting and is very unlikely to be of a pathological origin. Most probably, the depression was caused by a rounded solid object, probably a small pebble that exerted pressure on the bone during the early processes of fossilisation.

On the left, as on the right parietal bone, the outer surface is again flattened anteriorly around the anterosuperior angle and posteriorly around the postero-superior angle. In both parietals, the general external outline is rounded from side to side with prominent mid-parietal bossing and there are no parietal foramina seen.

The course of the superior temporal crest is the same on the left parietal bone as on the right parietal except that on the left side, due to some bone deficiency at the coronal margin, the course is interrupted. The

PLATE 12: External surface of the left parietal bone of the Laetoli Hominid 18 cranium. The left parietal bone unlike the right is incomplete, the bone is rectangular with well preserved sagittal, coronal, lambdoid and inferior borders. Note, the outer surface of the left parietal bone presents with an even rounded depression of about 10mm. in diameter at its posterior end near the lambdoid border.

pattern of the sutural margins is identical to that on the right side.

The inner surface of the left parietal bone (Plate 13) is also concave with a prominent parietal fossa. The impressions for the gyri of the left cerebral hemisphere and the vascular markings for the branches of the middle meningeal vessels (Fig. 3) on the left side parietal bone correspond in general to that on the right side.

(iii) <u>The occipital bone</u>

The occipital bone is represented solely by the large part of its squamous portion. The bone lacks its basiocciput and its exoccipital portions. The foramen magnum and its associated structures are entirely missing.

<u>The squamous part of the occipital bone</u>:

The squamous part of the occipital bone is almost complete and intact. That part of its postoccipital portion that bounds the foramen magnum is missing. The bone is broken off along the course of the inferior nuchal line. On either sides of the bone, the mastoid borders have also broken off a short distance from their lateral angles. The occipital squama is triangular with thick walls especially at the region of the superior angle and along the mastoid borders. The bone shows minor signs of surface erosion superiorly and along the course of the

PLATE13: Internal surface of the left parietal bone of the Laetoli Hominid 18 cranium. Note, the inner surface of the left parietal bone unlike the right parietal is incomplete. Like the right parietal the inner surface of the left is concave with a marked parietal fossa, the bone is thick, the sagittal and lambdoid sutural margins are serrated, the surface displays vascular grooves for the branches of the left middle meningeal vessels.

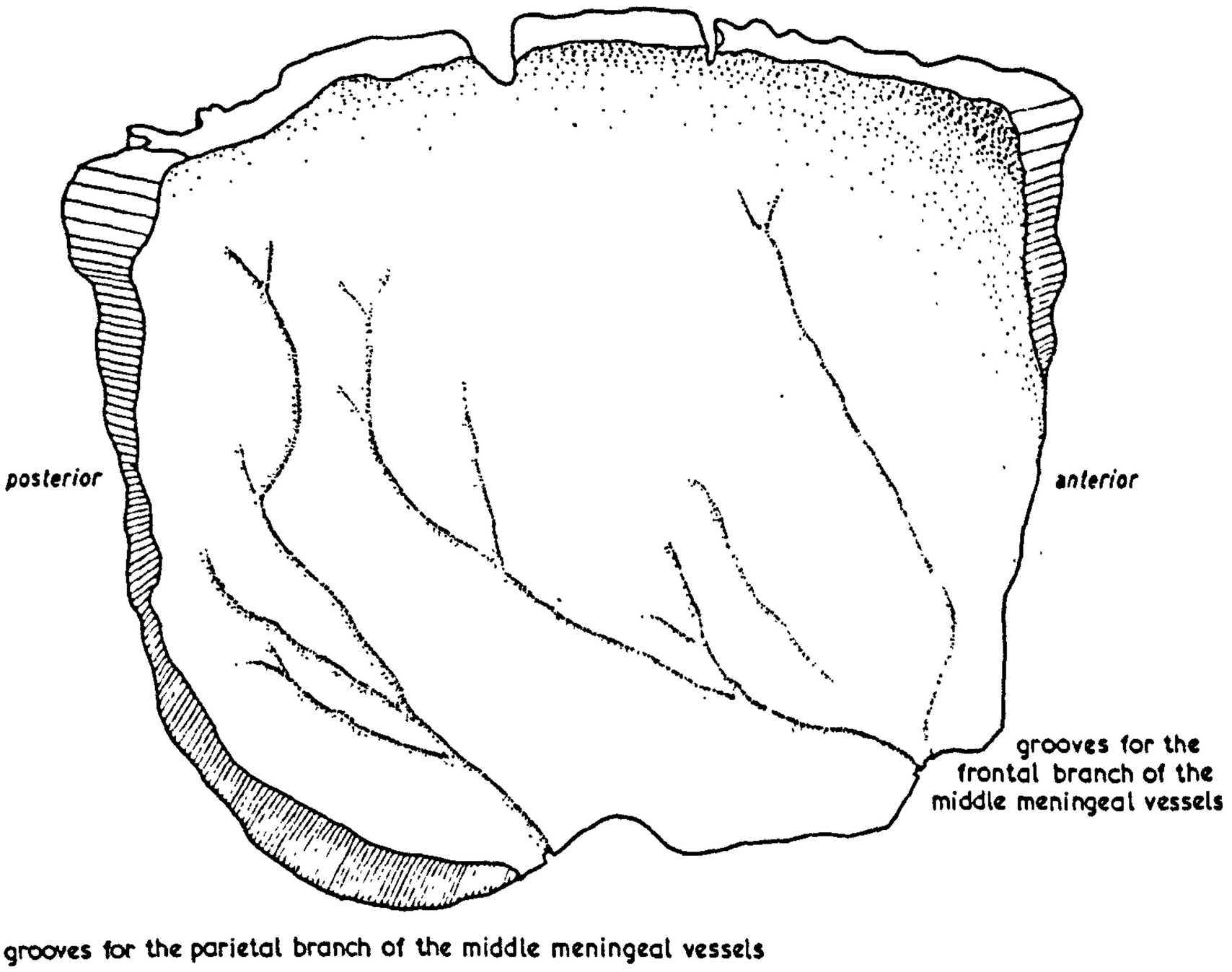


FIGURE 3: A graphical reconstruction of the vascular grooves for the branches of the left middle meningeal vessels of the Laetoli Hominid 18 cranium. Note, the pattern of the vascular grooves of the left parietal bone in general correspond to those on the right parietal.

external median crest. There are no signs of pathology and none of deformation.

The lambdoid borders are well preserved and deeply serrated. The borders extend downwards and laterally on both sides of the superior angle and end at the lateral angles. Both borders make an excellent fit with the corresponding occipital borders of the two parietal bones forming a well defined lambdoid suture. The mastoid borders are only partially preserved on both sides and are less serrated. On the left, due to some post-mortem plastic deformation affecting the left parietal and the left temporal bones, the temporal-occipital suture does not make good contact.

The external surface of the occipital squama (Plate 14) is clearly divisible into an upper supra-occipital part and a lower nuchal part separated by a prominent occipital torus. The supra-occipital part is rounded and smooth apart from the presence of a few cracks around the superior angle. Due to some slight bossing and roundness of the supra-occipital part, the position of the opisthocranion is well above that of the inion. It is difficult to define the exact location of the superior nuchal line, but the surface of the bone immediately below it is coarse and presents with a prominent undercut central occipital torus. The torus is of a uniform thickness in the vertical plane; laterally and inferiorly, it fades away and does not become continuous with the supramastoid crest. The position of the external occipital protuberance is ill-marked.

PLATE 14: External surface of the occipital bone of the Laetoli Hominid 18 cranium. Note, the squamous part of the occipital bone is almost complete and intact, the lambdoid border is complete and deeply serrated, the prominent undercut central occipital torus dividing the external surface of the bone into an upper supra-occipital part and a lower nuchal part.

The nuchal portion of the squamous part of the occipital bone is angulated anteriorly. The sites for the insertions of the nuchal muscles are well impressed. Thus, two oval depressions just immediately below the occipital torus can be regarded as the sites of the insertion of the semi-spinalis capitis muscle. The two depressions are limited below along the inferior nuchal line and are separated by external median crest. The crest, though prominent, is incomplete anteriorly due to bone breakage and shows signs of surface wear. The external median crest also presents with a centrally situated crack and posteriorly extends to the occipital torus. Immediately, inferolateral to the insertion of the semi-spinalis capitis muscle the bone surface is slightly coarse and elevated from the planum nuchale. The region can be considered as the site of insertion of the superior oblique and rectus capitis posterior major muscles.

The endocranial aspect of the squamous part of the occipital bone (Plate 15) is smooth and deeply concave. The surface shows some symmetry of the cranial fossae. The cerebral fossae are triangular and well preserved, they extend across the margins of the occipital bone on to the parietal bone. The cerebellar fossae on the other hand are incomplete anteriorly due to some bone loss. The internal occipital protuberance is well defined and is slightly lower than that of the inion on the occipital squama. The internal occipital crest runs downwards and forwards from the internal occipital protuberance. Unlike

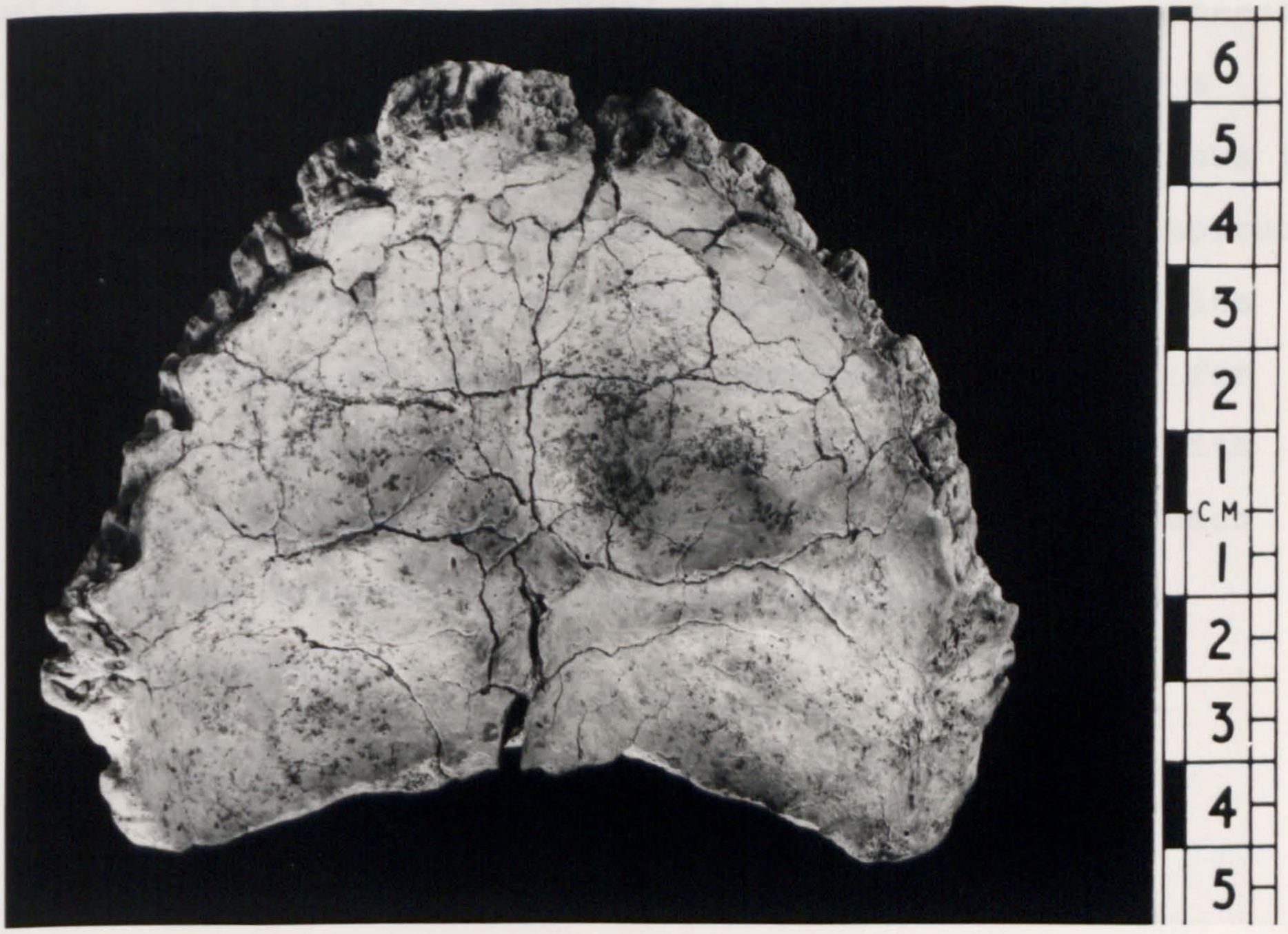


PLATE 15: Internal surface of the occipital bone of the Laetoli Hominid 18 cranium. Note, the concavity of the inner surface of the occipital bone, the two triangular shaped cerebral fossae, the two cerebellar fossae, the internal occipital crest and protuberance, the grooves for the sagittal, and lateral sinuses, (the groove for the sagittal sinus joins directly that of the right lateral sinus).

the external median crest, the internal occipital crest is flattened between the two cerebellar fossae and is very wide. Similar to the external occipital crest, the internal crest is also incomplete anteriorly and presents with a median crack. The groove for the superior sagittal sinus is poorly marked near the superior angle but becomes conspicuous near the internal occipital protuberance whereby it joins directly the right lateral sinus groove. The grooves for the right and left lateral sinuses are of equal size with ill-marked margins. The grooves extend laterally on each side of the internal occipital protuberance on to the lambdoid borders.

(iv) The Temporal Bones

Both temporal bones are preserved, the right temporal bone being better preserved than the left one.

The right temporal bone (Plates 16-18):

Apart from the styloid and zygomatic processes that have broken off, the right temporal bone is complete and intact. As a whole the bone still retains clearly its squamous, petrous and tympanic elements. The bone shows no signs of deformity and none of pathology but suffered from surface wear that affected particularly the petrous part.

The squamous part of the right temporal bone is complete and intact. Its inner and outer surfaces as well as

its superior and antero-inferior borders are all well preserved and intact. The superior border is thin with sharp edges. Internally the border is bevelled and runs obliquely making a nice fit with the corresponding surface of parietal bone at the squamosal suture. Posteriorly, the superior border curves slightly downwards and ends at an angle accommodating the inferiorposterior angle of the parietal bone. The antero-inferior border which is still in articulation with the posterior margin of the greater wing of the sphenoid bone, runs vertically downwards.

The outer surface of the squamous part of the right temporal bone is gently convex and smooth for the attachments of the temporal muscle fibres. On the surface, just above the opening for the external auditory meatus and running vertically, there is an ill-marked groove probably that for the superficial temporal artery. Below, the outer surface of the squamous part of the temporal bone is well separated from the opening of the external auditory meatus by the supramastoid crest. The crest is well marked and is continuous with the posterior root of the zygomatic process of the temporal bone. It then passes above the opening of the external auditory meatus before curving upwards along the posterior aspect of the outer surface of the squamous part of the temporal bone and does not become continuous with the superior temporal crest. The outer surface of the squamous part of the temporal bone also presents with a shallow depression for the suprameatal triangle bounded

PLATE 16: External surface of the right temporal bone of the Laetoli Hominid 18 cranium. Note, the right temporal bone is almost complete and still retains its squamous, petrous and tympanic elements. The superior border of the squamous part is well preserved, the antero-inferior border is still in articulation with the posterior margin of the greater wing of the sphenoid bone. The squamous part of the temporal bone is well separated from the opening of the external auditory meatus by a marked supramastoid crest, the occipitomastoid crest is well developed.

PLATE 16

between the anterior end of the supramastoid crest and the posterosuperior aspect of the external auditory meatus.

The zygomatic process of the right temporal bone is largely sheared off and only a small portion of its root is preserved. The root is only moderately thickened and has a broad triangular base. The posterior part of the root is represented by a conspicuous ridge that extends backwards and becomes continuous with the supramastoid crest. A small portion of the anterior part of the root juts almost horizontally from the side of the squamous part and is broken off at the region of the tubercle of the root of the zygoma. The medial end of the root becomes continuous with the articular eminence.

The glenoid fossa is well preserved. It is deep with a concave wall and is widened anteroposteriorly. In the mid-line, the fossa is clearly divisible into an anterior articular portion and a posterior non-articular portion by a poorly preserved squamotympanic fissure. The detailed anatomical features of the fissure are obscured due to the presence of a median crack that occupies the whole length of the fissure and to the presences of adherent matrix in this area. The articular part of the glenoid fossa has smooth walls and anteriorly is in direct continuation with the articular eminence. The tympanic plate forming the non-articular portion of the fossa, unlike the articular portion is damaged and shows signs of surface erosion that affected its anterior part.

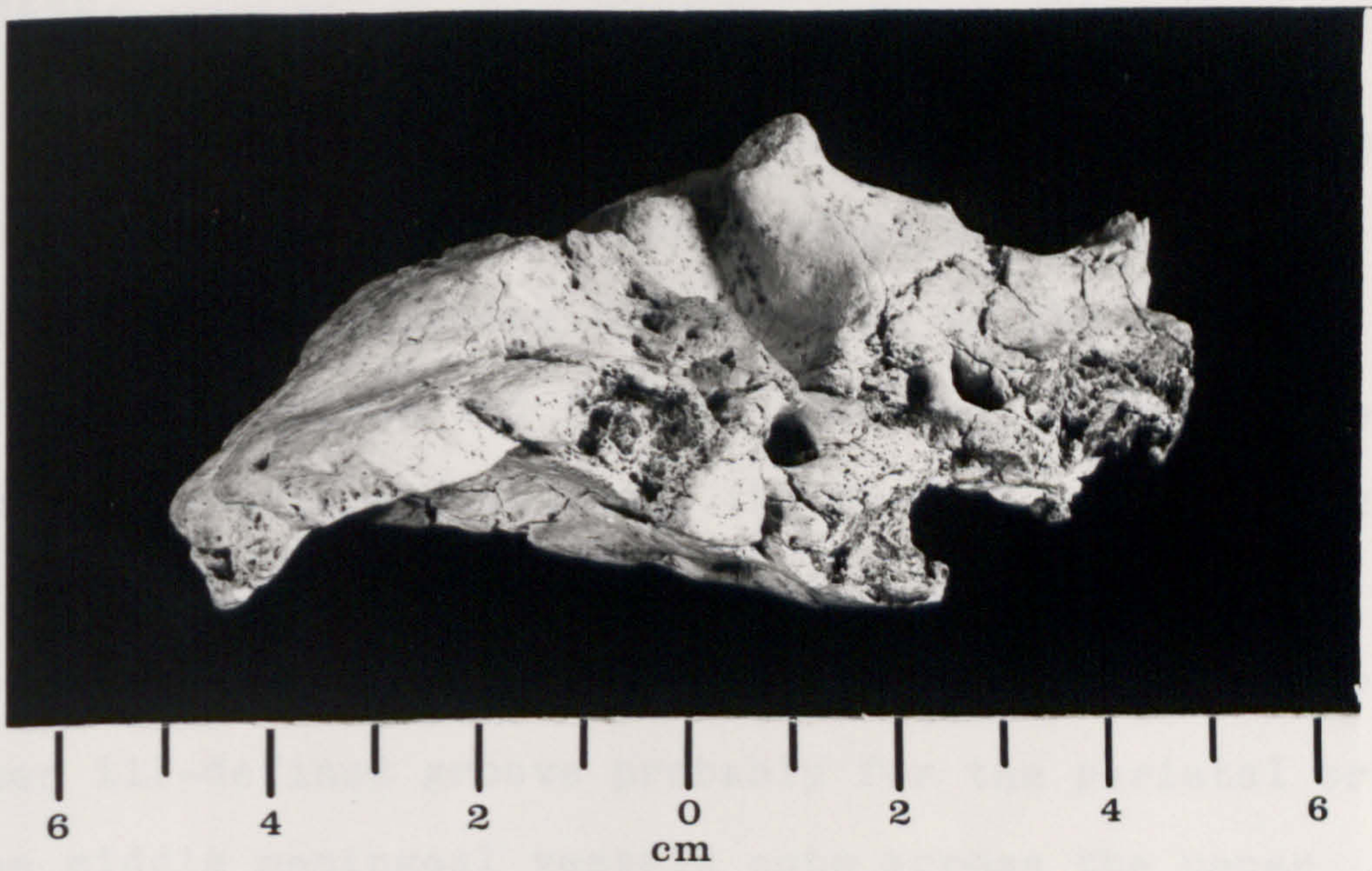


PLATE 17: Basal surface of the right temporal bone of the Laetoli Hominid 18 cranium. Note, the degree of surface wear of the bone, the preserved root of the zygomatic process with a broad triangular base and the glenoid fossa; the fossa is well preserved, is deep with a concave wall and is widened anteroposteriorly.

Thus, the surface of the tympanic plate is roughened and interrupted by grooves and cracks and a hole of about 2 mm diameter.

The cerebral surface of the squamous part of the temporal bone is concave. The surface is coarse and presents with impressions for the gyri of the temporal lobe of the cerebrum and for the branches of the middle meningeal vessels. Just above the foramen spinosum and running vertically upwards and anteriorly is a shallow groove for the frontal branch of the middle meningeal vessels. Another ill-defined groove probably for the parietal branch of the middle meningeal vessels cuts across the upper surface of the bone. The position of the petro-squamosal suture is not clearly defined.

The petrous part of the right temporal bone is only partially preserved. The bone has lost most of its apex and shows considerable degree of surface erosion. The anterior surface of the petrous part is badly damaged anteriorly and presents with a large lacerated cavity. Most of the bony elements forming the anterior margin for the opening of the canal for the internal carotid artery and the inferior margin of the foramen lacerum are missing. Due to the damage, the hiatus transmitting the greater petrosal nerve is turned into a deep groove with marked edges. The groove runs anteromedially towards the foramen lacerum. The bone surface around the arcuate eminence is roughened and shows a remarkable degree of

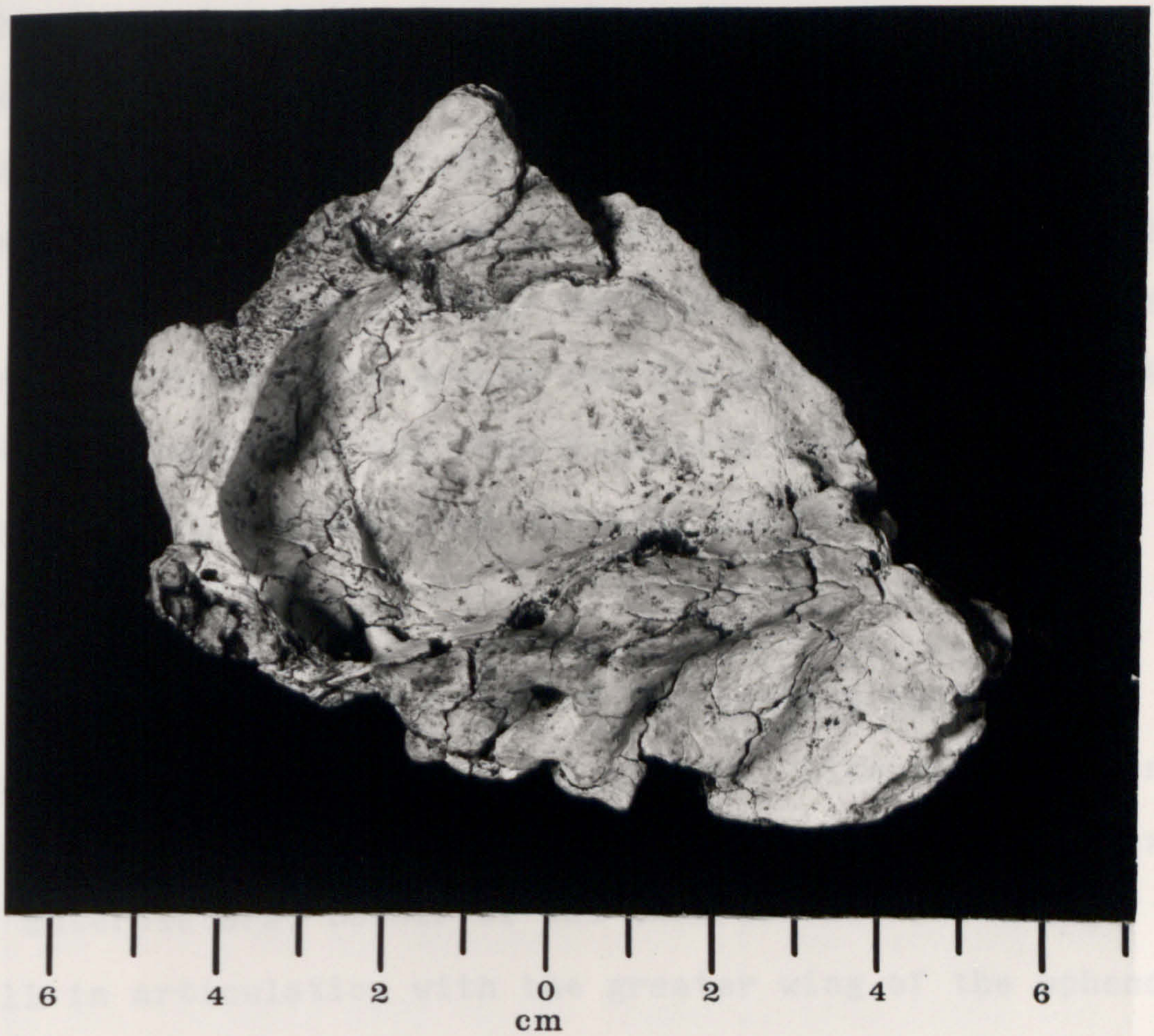


PLATE 18: Inner surface of the right temporal bone of the Laetoli Hominid 18 cranium. Note, the cerebral surface of the squamous part of the temporal bone is concave, the position of the foramen spinosum, the opening of the internal auditory meatus and the groove for the superior petrosal sinus.

surface wear. Immediately anterior to the arcuate eminence, the anterior surface of the petrous part presents with a circular hole of about 3 mm diameter that opens inferiorly on to the non-articular surface of the glenoid fossa and is the result of damage. Apart from the surface wear, the anterior surface is also marked by the impressions for the gyri of the inferior surface of the temporal lobe of the cerebrum. The groove for the superior petrosal sinus is very conspicuous and runs obliquely from the superior margin of the petrous bone and ends abruptly medially at the lacerated cavity.

The inferior surface of the petrous part of the temporal bone is roughened and uneven. Like the anterior surface, the inferior surface also lacks most of its apex. The anterolateral border of the inferior surface though still in articulation with the greater wing of the sphenoid bone, shows a considerable degree of surface wear. The styloid process is broken off and only the position of its root can be located just behind the lower edge of the tympanic plate. The position of the root of the styloid process together with that of the stylomastoid foramen are obscured by hard matrix. Medially near the apex, the inferior surface of the temporal bone presents with a circular opening for the lower end of the carotid canal. The canal is well preserved, passes upwards, forwards and medially. As it approaches the apex, it is devoid of its roof and ends abruptly into the irregular cavity formed by some bone deficiency at this region.

The tympanic part of the temporal bone is largely intact and curves around the opening of the external auditory meatus. Its upper surface forms the anterior, inferior and part of the posterior wall of the external auditory meatus, it is smooth and concave. A portion of the anterior surface has broken off leaving behind a roughened surface with still clearly defined upper, lower and lateral borders. The lower border of the anterior surface is sharp and extends downwards to ensheath the root of the styloid process. The lateral border is thick, rough and curved. The squamotympanic, tympanomastoid and to a lesser extent the petrotympanic fissures are all clearly seen. The external auditory meatus is a small rounded opening directed medially and slightly forwards and downwards. Its walls are complete and intact. Its roof and part of its posterior wall are formed by the squamous part of the temporal bone while the tympanic part of the temporal bone forms its anterior wall, floor and the lower part of its posterior wall. Its floor is the thickest part of the tympanic plate and is slightly convex superiorly.

The mastoid part of the temporal bone is complete and separated from the tympanic part by the tympanomastoid fissure. Its superior border is thick, intact, serrated and makes a good articulation with the mastoid angle of the parietal bone. The posterior border, like the superior, is intact and moderately serrated and makes a nice fit with the inferior border of the squamous occipital. The outer surface of the mastoid portion of the temporal bone

is uneven, roughened and presents with a small conical mastoid process. The process is directed downwards and slightly medially and is limited both medially and posteriorly by deeply incised mastoid notch. The lateral surface of the mastoid process is roughened for the attachment of the sternocleidomastoid, splenius capitis and longissimus capitis muscles. Medially, the mastoid notch is limited by a prominent occipitomastoid crest. There is no groove for the occipital artery. The mastoid emissary foramen is blocked by matrix and is immediately above the occipitomastoid crest. The inner surface of the mastoid portion of the temporal bone is crossed by a deeply curved groove for the sigmoid sulcus.

The left temporal bone (Plates 19-21)

Unlike the right temporal, the left temporal bone is incomplete. The bone lacks most of its squamous part but still retains its tympanic and petrous parts. The styloid process is totally missing and only a small portion of the zygomatic process is still retained. Like the right temporal, the left temporal bone shows signs of surface erosion that affected particularly the petrous portion. There are no signs of pathology and none of deformity.

The squamous part of the left temporal bone is missing, just a short distance above the supramastoid crest. Anteriorly, the bone still retains part of its antero-inferior border that articulates with the posterior margin of the greater wing of the sphenoid bone.

The root of the zygomatic process together with a short portion of its process is preserved on the left temporal bone. As on the right temporal, the root on the left side is only moderately thickened with a broad triangular base. Posteriorly the root is continuous with the supramastoid crest. The glenoid fossa of the left temporal bone, like that on the right side, is well preserved and complete. The two fossae display similar anatomical features but the presence of the tegmen tympani on the left side is more evident. The tympanic plate forming the non-articular portion of the glenoid fossa is intact.

The preserved cerebral surface of the squamous part of the left temporal bone reveals identical anatomical features to those on the right side. Thus the surface presents with impressions for the gyri of the temporal lobe of the cerebrum and for the branches of the middle meningeal vessels. A shallow groove probably for the frontal branch of the middle meningeal vessel runs vertically upwards for a short distance and then divides into two. One of the grooves runs vertically upwards and anteriorly while the second groove immediately curves posteriorly and runs on the lower surface of the bone. The position of the temporosquamosal suture is not clearly defined.

The petrous part of the left temporal bone is only partially preserved. The bone has lost most of its apex and shows a considerable degree of surface wear. The anterior surface of the petrous part is heavily eroded and

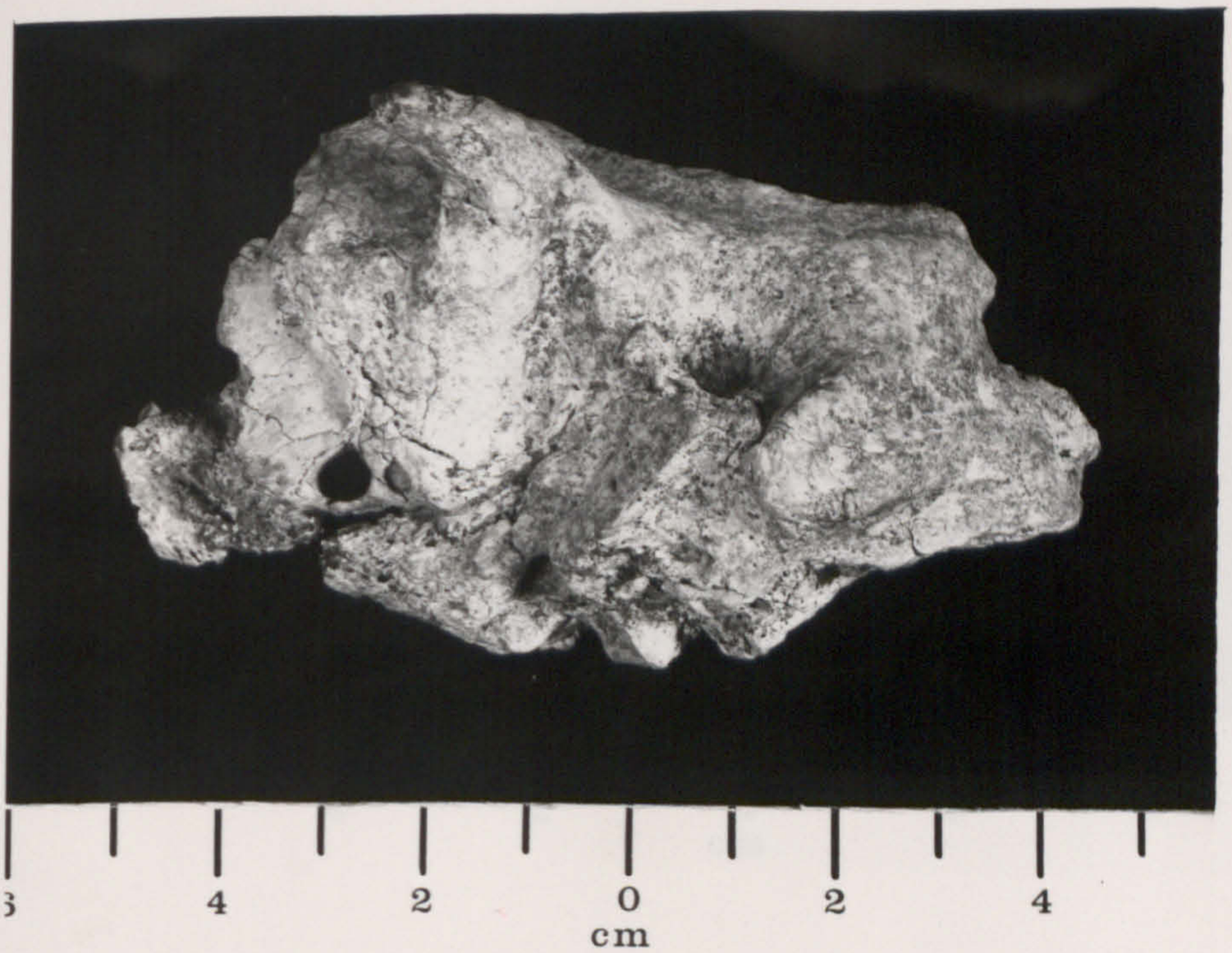


PLATE 19: The external surface of the left temporal bone of the Laetoli Hominid 18 cranium. Note, the left temporal bone unlike the right is incomplete and only a portion of the squamous part of the bone is preserved. As on the right temporal bone, the left also still retains a small portion of the zygomatic processes, the root is moderately thickened and has a broad triangular base, the glenoid fossa is well preserved, the mastoid process is small and the external auditory meatus is well located.

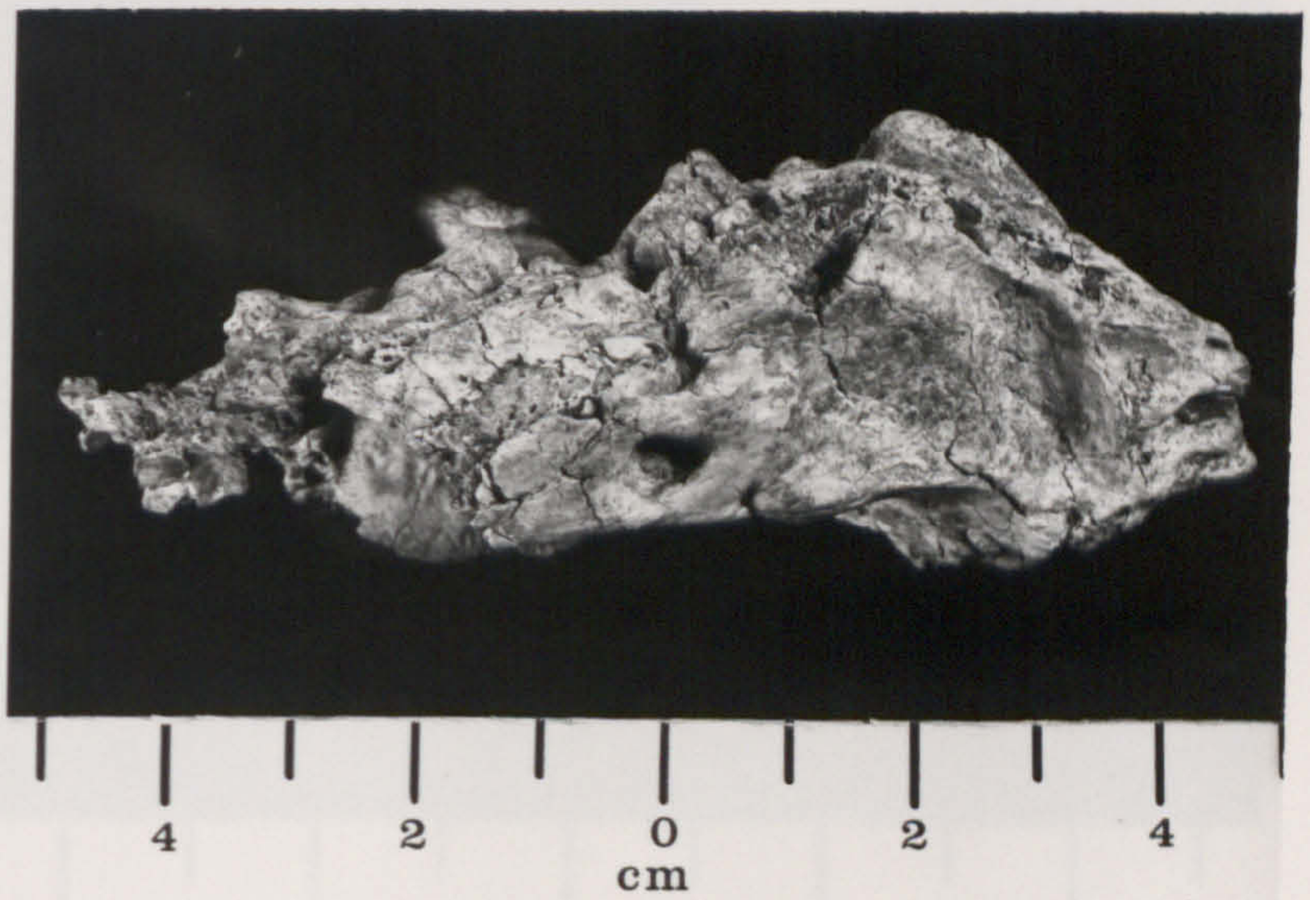


PLATE 20: Basal surface of the left temporal bone of the Laetoli Hominid 18 cranium. Note, the degree of surface wear of the bone, the articulation of the squamous part of the left temporal bone with the greater wing of the sphenoid bone.

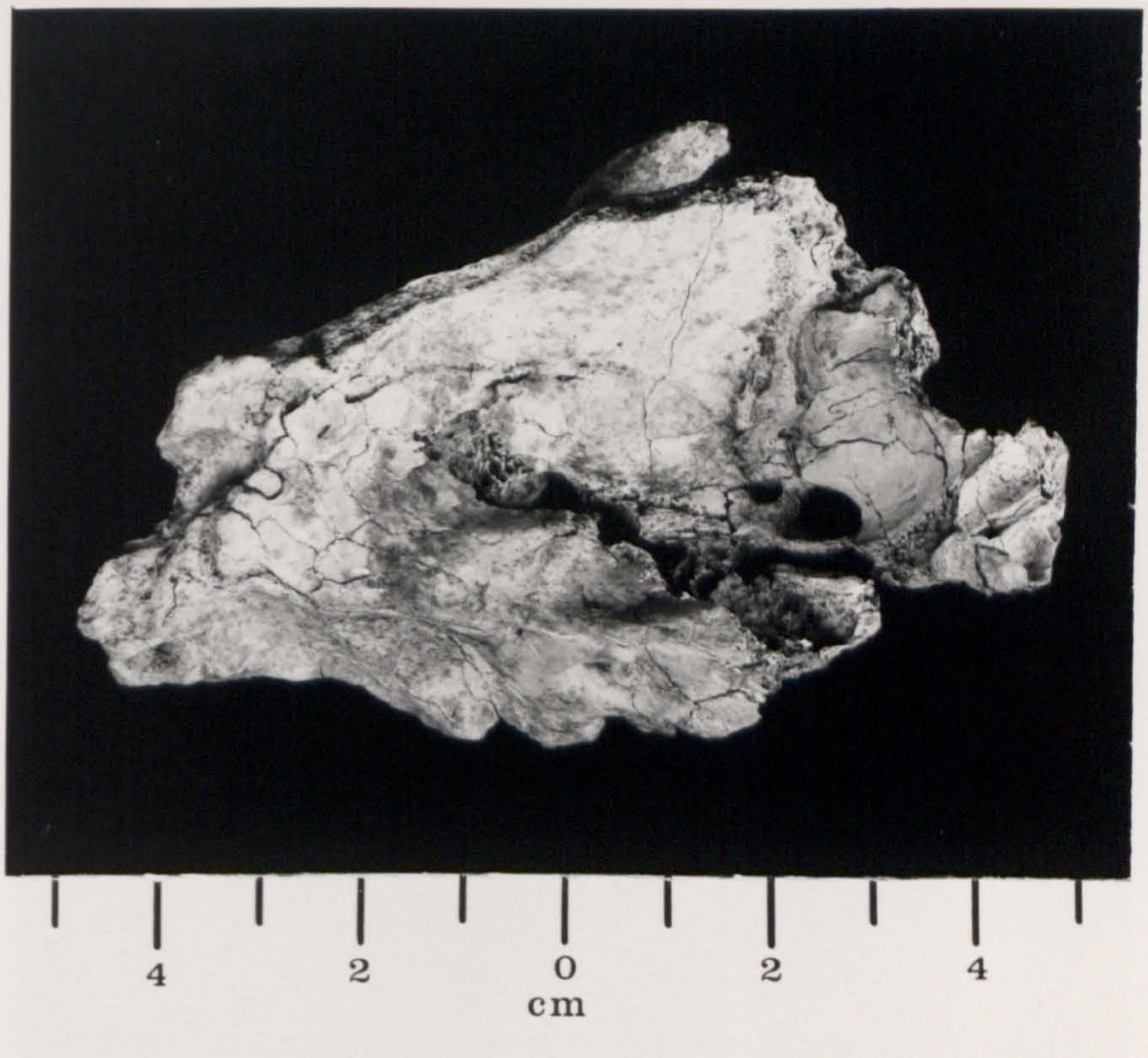


PLATE 21: The inner surface of the left temporal bone of the Laetoli Hominid 18 cranium. The preserved inner surface of the left squamous part of the temporal bone is concave, the surface is greatly affected by surface erosion.

presents with an irregular lacerated cavity that extends from the apex up to the region of the arcuate eminence posteriorly. The groove for the superior petrosal sinus is very conspicuous and takes an oblique course from the superior margin and ends abruptly medially into the lacerated cavity.

As on the right side, the inferior surface of the petrous part of the left temporal bone is roughened and uneven. Its apex is missing as well as the styloid process. Only the position of the root of the styloid process can be located just behind the lower edge of the tympanic plate. As on the right side, the lower circular opening of the carotid canal is preserved.

The tympanic and the mastoid parts of the left temporal bone like those of the right side are complete and intact. Both sides show similar anatomical details. Unlike the right side, however, the prominent occipito-mastoid crest is not preserved on the left side.

(v) <u>The sphenoid bone</u>

The sphenoid bone is preserved in part on either side of the cranium. The body of the sphenoid bone is represented by part of its lateral surface still in direct articulation with the greater wing of the sphenoid bone on the right side, while on both sides part of the anterior surface of the body, revealing a portion of the sphenoidal air sinus,

is preserved. The greater wing of the sphenoid bone is almost complete on the right side and consists of the lateral, cerebral and orbital surfaces. The lateral surface is clearly divisible into an upper temporal surface and a lower infratemporal surface by a well marked infratemporal crest. The temporal surface is concave and still retains its posterior margin articulating with the anteroinferior margin of the squamous part of the temporal bone. Its upper border is missing in part and has no direct articulation with the frontal bone. The preserved upper border of the greater wing of the sphenoid bone articulates with the antero-inferior part of the parietal bone and the squamous part of the temporal bone to form an H-shaped sutural pattern at the pterion. The infra-temporal surface is also concave and shows surface wear at its posterior angle. The surface is pierced by the foramen ovale and foramen spinosum partially occluded by hard matrix. The cerebral surface of the greater wing of the sphenoid bone on the right side is well preserved and deeply concave. The surface presents with depressions corresponding with the convolutions of the anterior part of the temporal lobe of the cerebrum. The foramen rotundum is preserved at the anteromedial part of the cerebral surface. As on the inferior aspect, the cerebral surface is also pierced by the foramen ovale and foramen spinosum. The orbital surface of the greater wing of the sphenoid bone is almost intact with well preserved upper, lateral and medial borders. On the left side only part of the infratemporal

surface of the greater wing is preserved. As on the right side, the posterior portion of the infratemporal surface on the left suffered from surface erosion. The surface also presents with the foramen ovale and foramen spinosum blocked by hard matrix. Part of the lesser wing including part of the optic canal is preserved on the right side. Both pterygoid processes of the body of the sphenoid bone are broken away.

(vi) The facial bones of Laetoli Hominid 18 (Plates 22-27)

The facial skeleton of Laetoli Hominid 18 skull is only partially preserved and has been restored from seven separate bone fragments and isolated teeth. The bone fragments constitute paired maxillary bones, each consisting of the body together with the zygomatic process, the alveolar process bearing some teeth, the palatine process and the frontal process on the left side. Though the facial bones show some degree of damage they show neither signs of plastic deformation nor of pathology.

The body of the maxilla on the left side is almost intact and consists of anterior, posterior, orbital and nasal surfaces, while on the right side, only the anterior surface of the body is restored. On both sides, the lower part of the anterior surface of the body shows remarkable degree of surface wear thus exposing the roots of some of the upper teeth. The anterior surface of the body as a whole

on both sides is concave and is directed forwards and slightly laterally. The incisive and the canine fossae as well as the canine eminence are not well marked. On the left maxilla the anterior surface presents with a well preserved infra-orbital foramen as well as part of the infra-orbital canal. Only part of the posterior surface is preserved with an ill-marked maxillary tuberosity on the left side. The orbital surface of the body of the maxilla on the left side is represented by a part of its anterior and medial borders. The whole of its posterior border is missing. The medial border presents with the lacrimal fossa together with the nasolacrimal duct anteriorly. The preserved part of the nasal surface on the left maxilla is smooth and concave. Due to the breakage of the nasal, orbital, and infra-orbital surfaces of the body of the maxilla on both sides, and of the anterior surface on the right side, both maxillary air sinuses are exposed. The left sinus is better preserved than the right one. This sinus is large and is divided into smaller cavities by incomplete radiating septa. Its nasal, orbital and infra-orbital walls as well as its floor are only partially preserved.

Both zygomatic processes are partially preserved and spring laterally at an angle just over 90^{o} from the body of the maxillae.

The frontal process is preserved on the left side. Its medial and lateral surfaces are intact while its apex is broken away about 10 mm from the frontal bone thus

preventing a direct articulation with the rest of the skull. The anterior process projects upwards and backwards while its lateral surface presents with a moderately marked anterior lacrimal crest. The part of the bone just below the lacrimal crest is smooth and merges below with the anterior surface of the body of the maxilla. The medial surface of the frontal process forming a part of the lateral surface of the nasal cavity is smooth and concave.

The alveolar process bearing some teeth is only partially preserved on both sides. Its inferior margin is irregular and reveals a marked degree of post-mortem damage. Part of the alveolar bone is lost and thus exposes a number of tooth roots and tooth alveoli. The exposed alveoli include those of I^2, C, and P^3 on the left and I^2, C on the right side. The preserved teeth include P^3, P^4, and M^1 on the right and the stump of P^4 as well as M^1, M^2, and M^3 on the left. All the teeth are heavily worn with no trace of cusps and fissure pattern. From the evidence afforded by the state of the dental alveoli for the anterior dentition, it is most likely that the missing teeth have been lost post-mortem.

The palatine process of the maxilla, like the alveolar process, is also partially preserved on both sides. Its inferior surface forming the roof of the mouth is deeply concave, rough and broadened. When the two maxillae are articulated together, there is evidence of

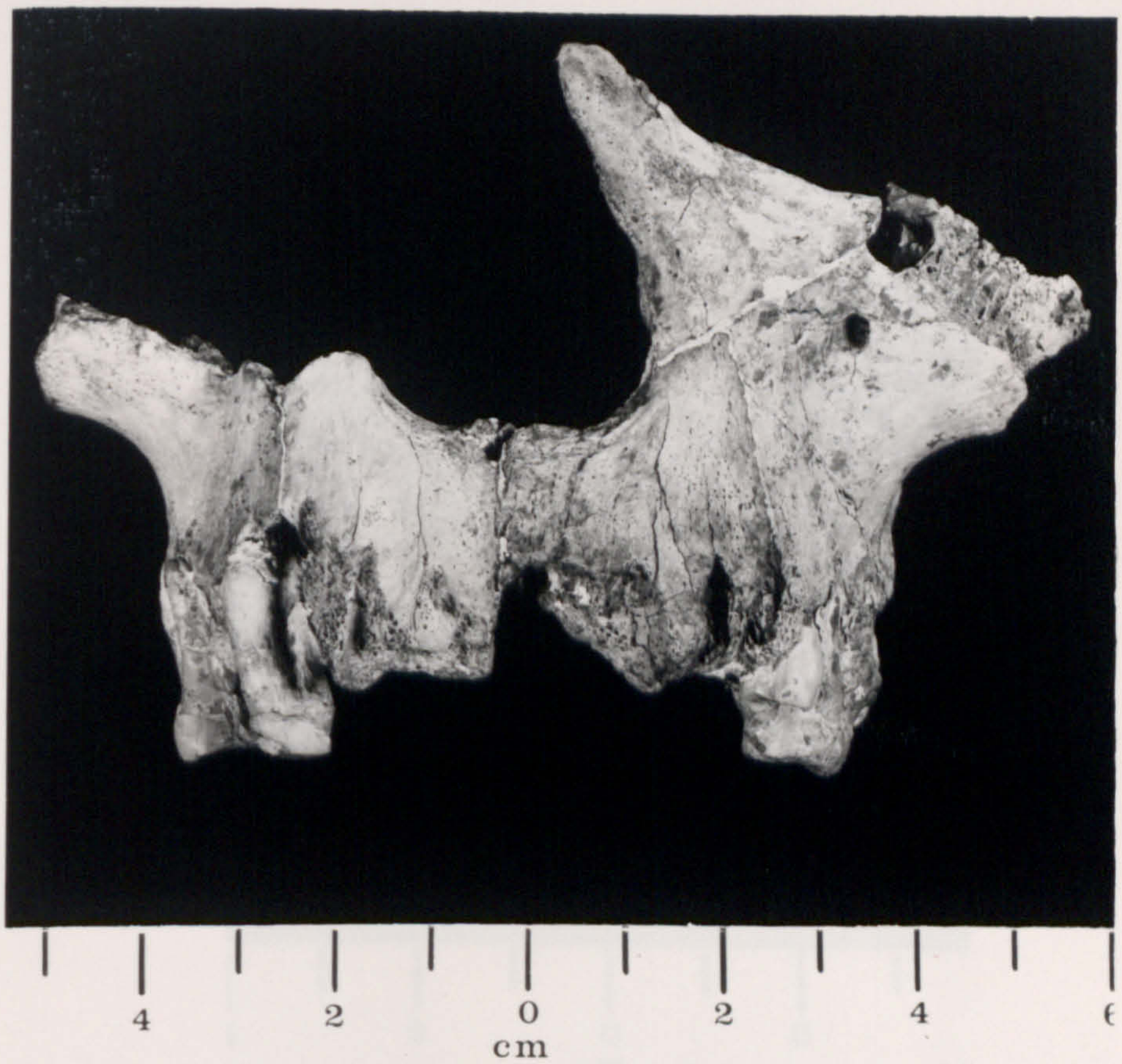


PLATE 22: Anteroposterior view of the maxillae of the Laetoli Hominid 18 cranium. Note, the position of the infra-orbital foramen on the left side and the springing of the zygomatic processes from the body of the maxillae at an angle just over 90°, the frontal process of the maxilla is preserved on the left side, the nasal aperture is pear-shaped and the inferior margin of the alveolar process is irregular and reveals marked degree of post mortem damage.

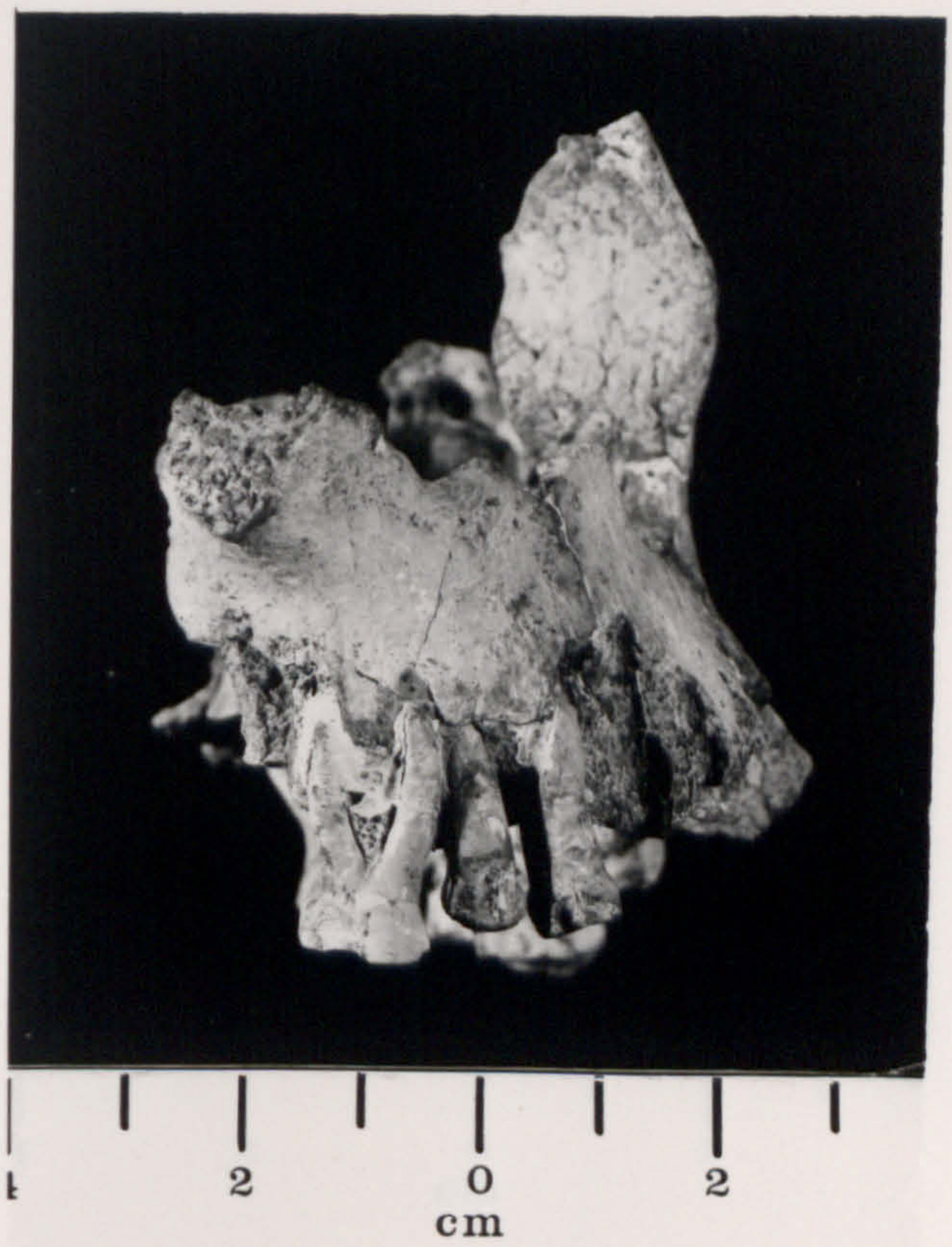


PLATE 23: The right lateral view of the maxillae of the Laetoli Hominid 18 cranium. Note, the degree of the alveolar prognathism and the roots for P^3, P^4, and M^1.

PLATE 24: Left lateral view of the maxillae of the Laetoli Hominid 18 cranium. Note, the degree of the alveolar prognathism, the preserved teeth including the stump of P^4 as well as M^1, M^2 and M^3.

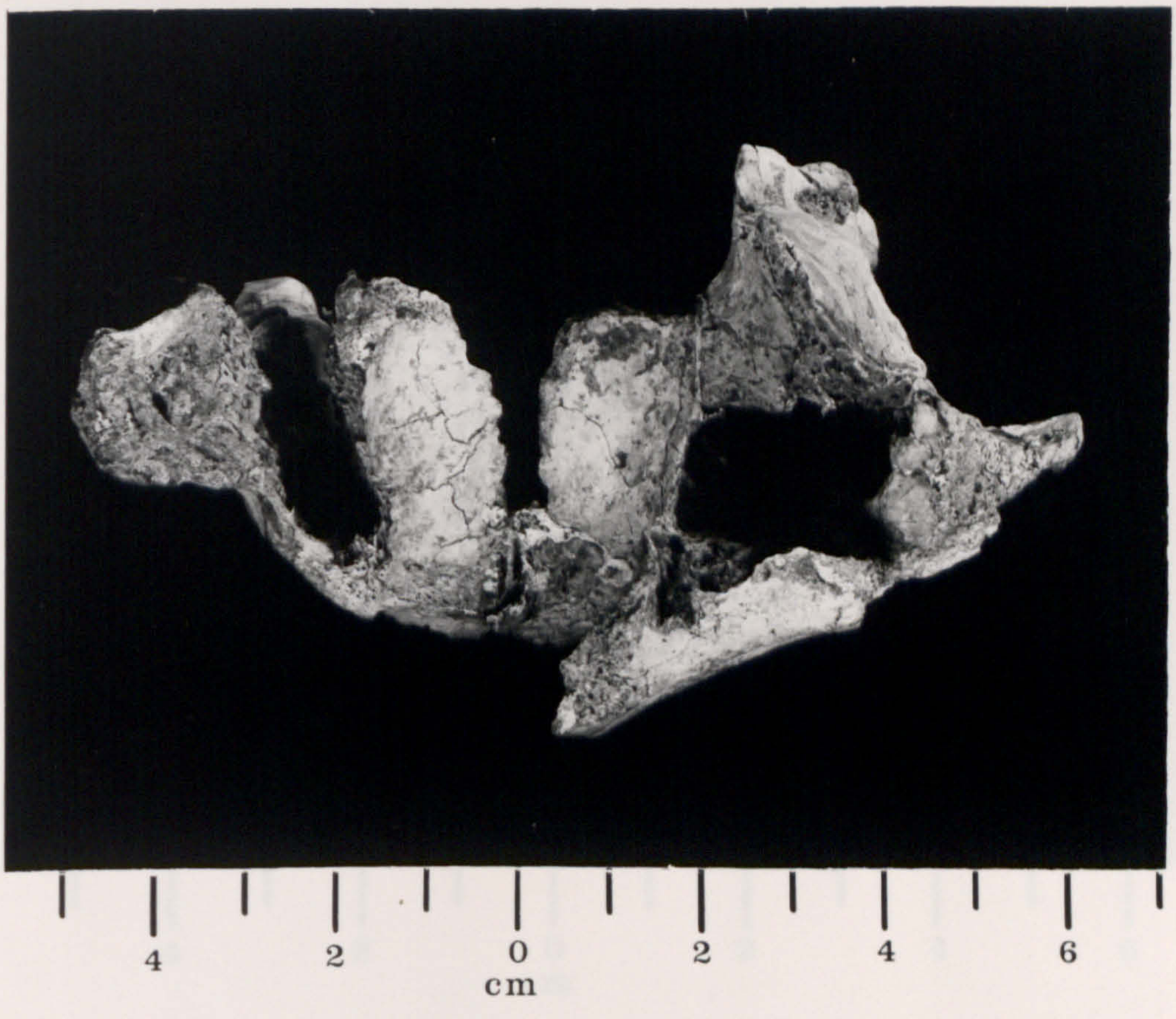


PLATE 25: The maxillae of the Laetoli Hominid 18 cranium focusing at the upper surface of the palate. Note the two maxillary air antra. The left maxillary air antrum is better preserved than the right one, and is large. Its nasal, orbital and infra-orbital walls as well as its floor are only partially preserved.

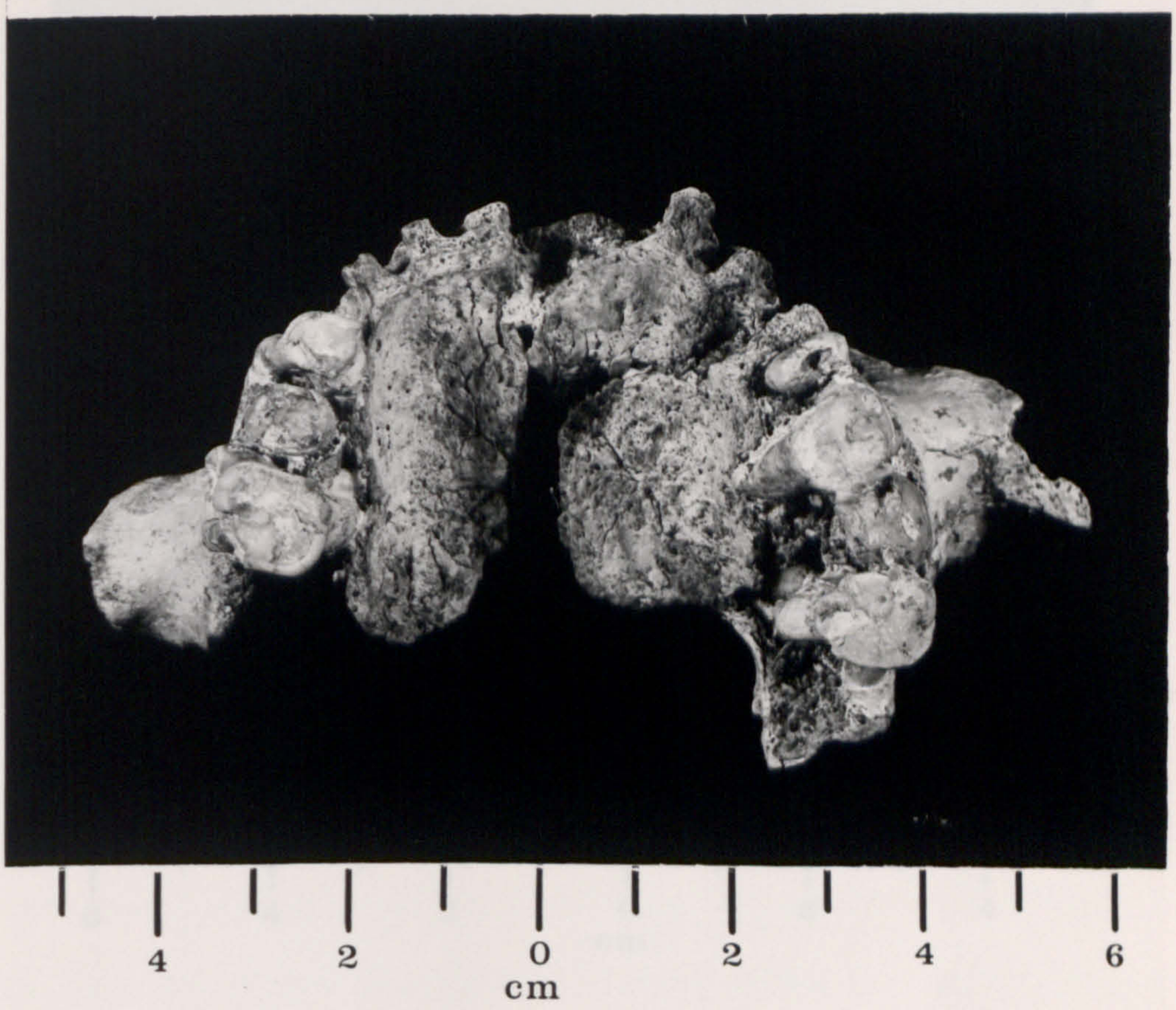


PLATE 26: Basal view of the maxillae of the Laetoli Hominid 18 cranium. Note, the parabolic shaped dental arcade, the palate is incomplete but is wide and deep; all of the preserved teeth are badly worn.

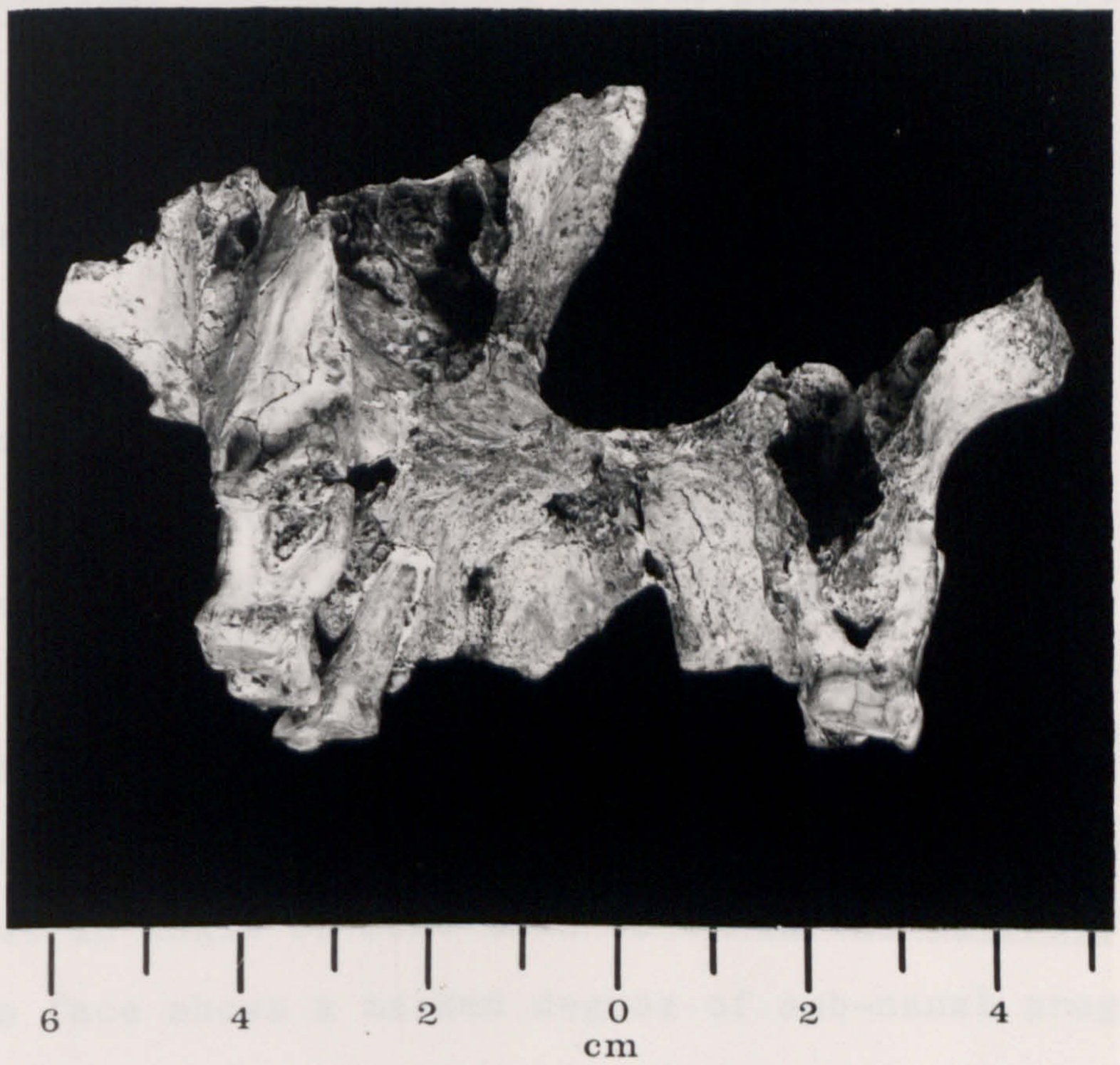


PLATE 27: Basal view of the maxillae of the Laetoli Hominid 18 cranium. Note, the pear-shaped nasal aperture, the two maxillary antra and the extent of the roots for P^4 and M^1 on the right and M^3 on the left.

the presence of an incisive fossa. The upper surface of the palatine process is similarly concave from side to side and is smooth. Though a part of its medial border is missing, still there is strong evidence for the presence of a nasal crest for the reception of the vomer, and an incisive crest together with the anterior nasal spine.

Considering the two maxillae together, the following features are revealed; the frontal view reveals a broadened face with a pear shaped nasal aperture, there is evidence of the presence of a nasal spine. The floor of the nose is broad and gutter-shaped with a median crest for the articulation with the vomer. Both zygomatic processes are seen to spring laterally, well above the alveolar margin at an angle of more than 90^{o}. In the lateral view the face shows a marked degree of sub-nasal prognathism so that the anterior dentition would seem to have projected to a considerable degree. The basal view reveals a deepened and broadened U-shaped palate.

(c) Radiographic examination of the Laetoli Hominid 18 cranium (Plates 28-36)

In recent years, radiography has been of much value in the study of fossilised bones. The technique as used in clinical practice, affords the visualisation of the internal structures of the bones that otherwise would not show from the external appearance. In addition, by the application of the specialised techniques, such as tomographs,

it is possible to demonstrate the presence and extent of bone anomalies whether pathological or non-pathological. The previous workers who have employed radiography in the studies of fossil man include, Bonnet (1919) who examined the internal structures of the long bones of the Neanderthalers as a group; Singer (1958) who used lateral view radiographs to compare the form of the frontal bone in the Florisbad, Rhodesian and Saldanha skulls; Weidereich (1951) who used radiographs to describe what he called a post-jugularis fossa in the base of Solo IV and XI skulls. Various workers, (Patte, 1955; Vallois, 1958; Corrain, 1963; and Vlcek, 1968) have used radiographs to show the degree of development of the frontal sinuses.

Despite its wide use, there have been some problems with the radiographic techniques when applied to the study of fossilised bones. Fossil material by its fragmentary nature can raise special radiographic problems, also heavily mineralised bone requires greatly increased dosage if the X-rays are to penetrate the radio-opaque impregnating mineral (Brothwell et al., 1969). Another major problem concerns the lack of standardized techniques. Thus, the X-ray head/specimen distance should be constant for a given bone so that radiographs are comparable. Attention needs to be paid to the orientation of the material, particularly when it is fragmentary, as the temptation is to let the bone rest naturally on the film which obviously rules out any possibility of standardization (Brothwell et al., 1969).

PLATE 28: Radiograph of the calotte of the Laetoli Hominid 18 (vertical view). Note, the extent of the frontal air sinuses. The frontal air sinuses are well preserved and present as two widely separated, rather small, oval-shaped loculi. The loculi measure 14mm. in height, 16mm. in depth and 50mm. in total width. They are simple and not subdivided loculi as is often encountered with small sinuses. The frontal air sinuses do not fill the brow-ridges, leaving a large unpneumatized area in the midline and at the lateral aspects of the orbits. They are more like the sinuses encountered during the growth period and fall within the range of sinus size observed in modern populations. The median septum is exceptionally wide (15mm. across). Such a wide septum is not often encountered in modern skulls but has been observed in one or two of the Tibetan X-ray series examined at the British Museum (Natural History).

Exposure factors (65kV, 5mA, 5x30s, 99cm. FFD) of KD 54T Kodak T film, fine focus.

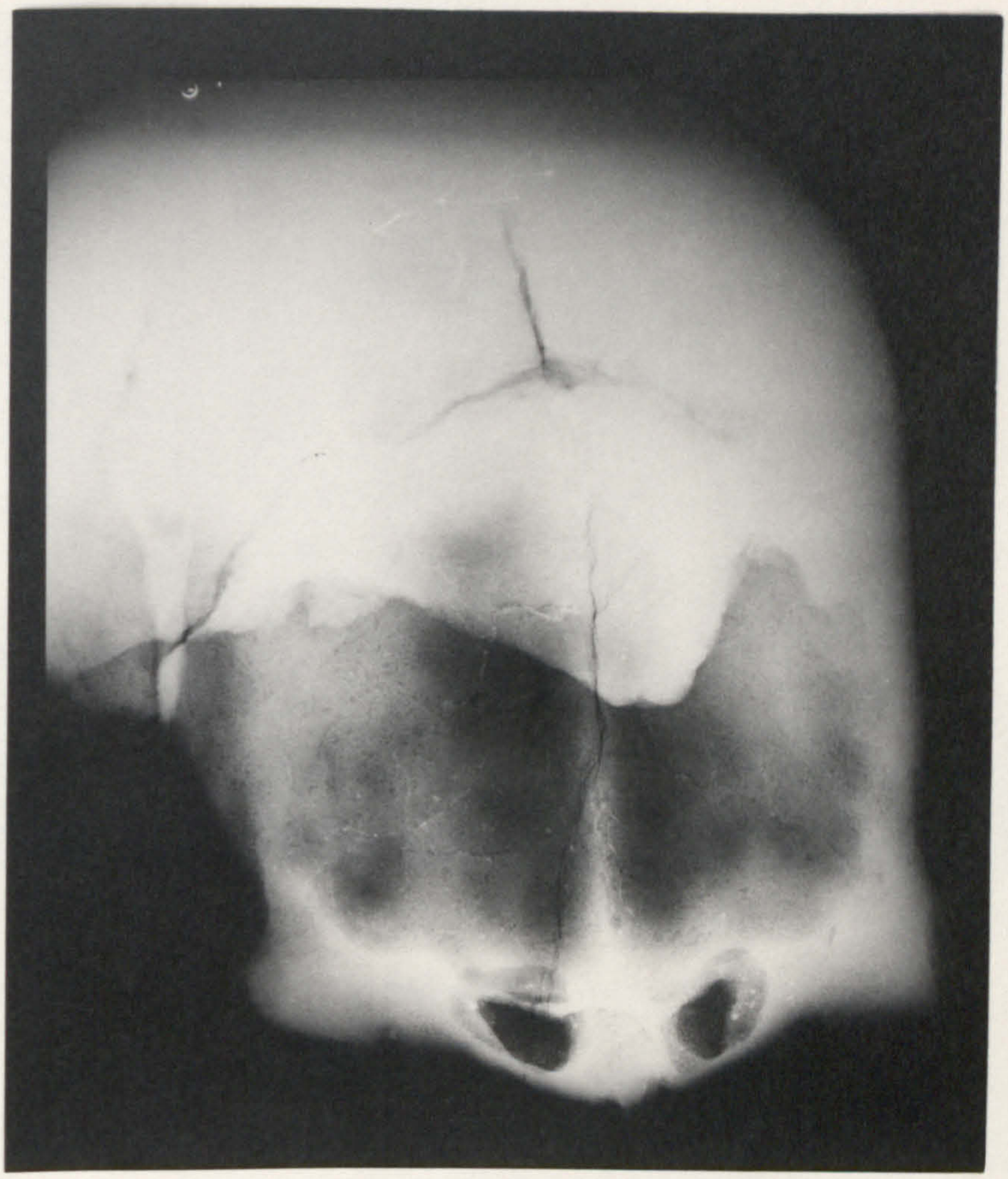


PLATE 28

PLATE 29: Radiograph of the calotte of the Laetoli Hominid 18 (Right parietal bone on the film). Note, the right lateral view of the frontal, parietal and occipital bones are clearly shown together with the outlines of the coronal and lambdoid sutures. The low set of the cranial vault, the recession of the frontal region, the shallow ophryonic groove and the roundness of the occipital region. The frontal bone is heavily and evenly thickened and shows only slight degree of pneumatisation anteriorly for the frontal air sinuses. The parietal and occipital bones, like the frontal, are also heavily and evenly thickened. The parietal bone is particularly thickened along the lambdoid border while the occipital bone is more thickened at the region of the occipital torus.

Exposure factors (75kV, 5mA, 5x10s, 99cm. FFD) of Blue Brand Kodak film, fine focus.

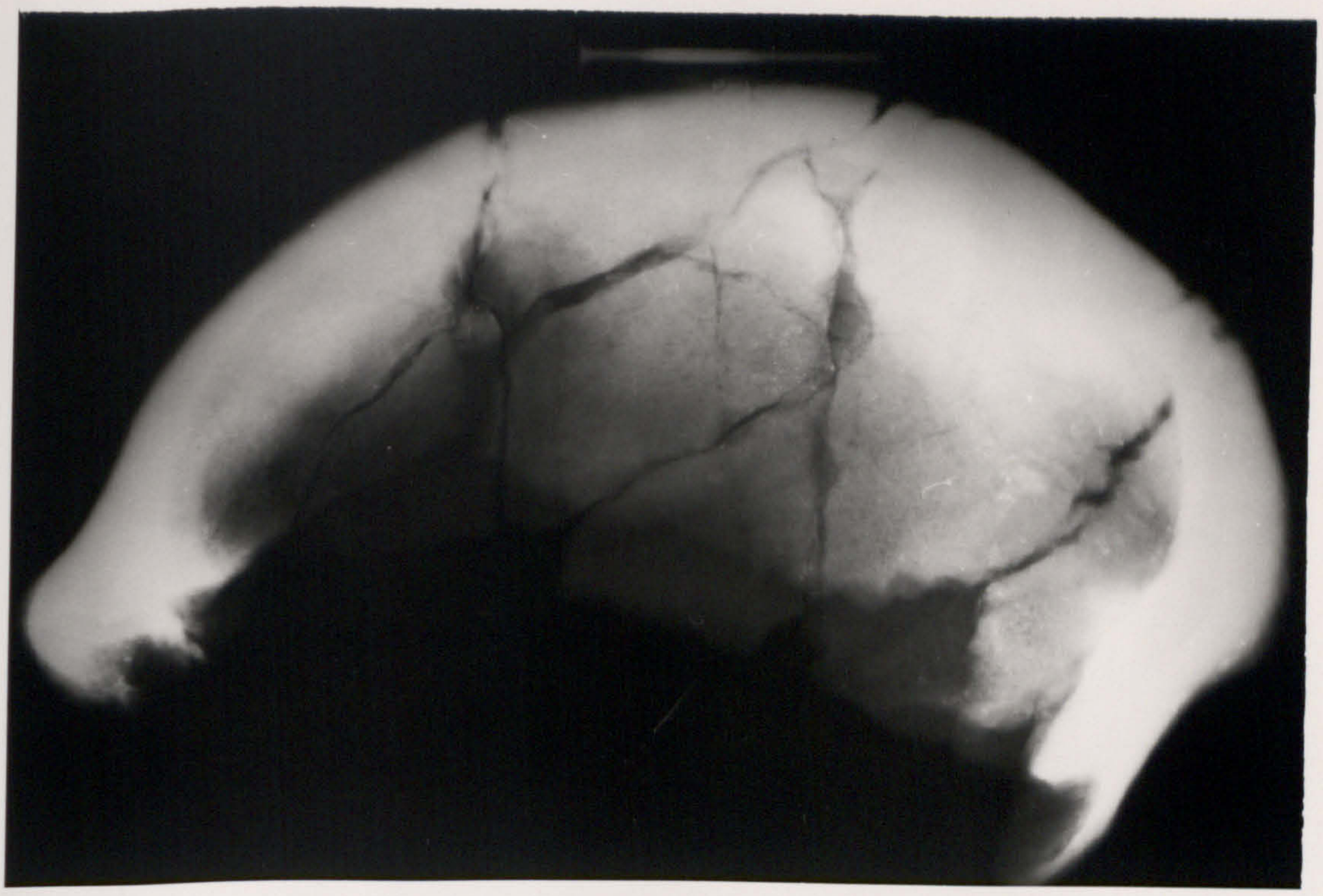


PLATE 29

PLATE 30: Radiograph of the calotte of the Laetoli Hominid 18 (left parietal bone on the film). Note that the frontal, parietal and occipital bones are almost complete. The coronal together with the lambdoid sutures are clearly shown. The cranial vault is low, the frontal region is receeding and with a shallow ophryonic groove while the occipital region is evenly rounded. The degree of thickness of the frontal, parietal and the occipital bones is similar to that of the right parietal bone. The left parietal bone unlike the right, presents with a small evenly rounded anomaly at its postero-lateral aspect, close to the lambdoid border. The anomaly is better demonstrated in Figure 40.

Exposure factures (75kV, 5mA, 5x10s, 99cm. FFD) of Blue Brand Kodak film, fine focus.

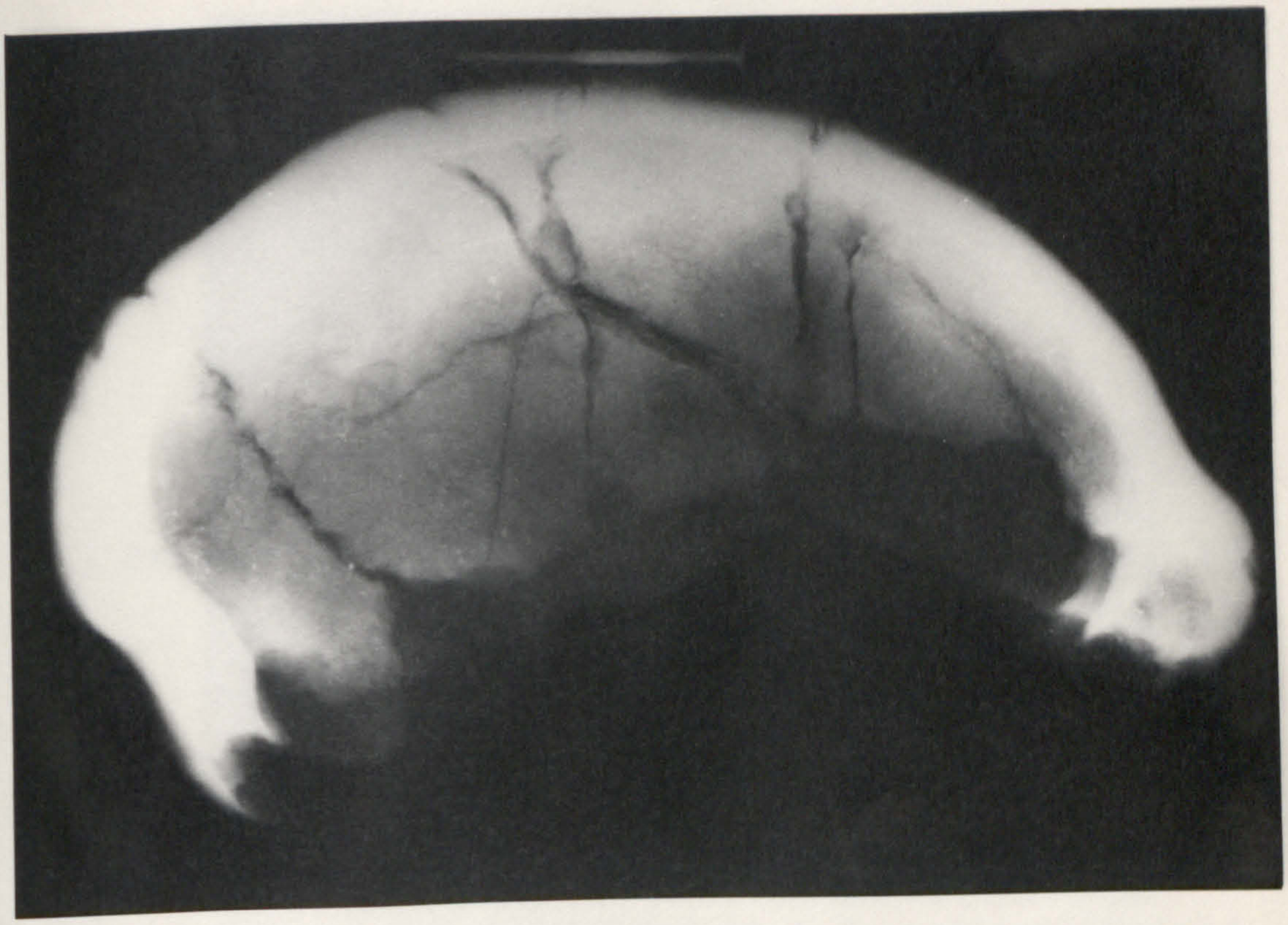


PLATE 30

PLATE 31: Radiograph of the calotte of the Laetoli Hominid 18 (left parietal bone on the film, focussing at the bone anomaly). Note, at the posterolateral aspect of the left parietal bone close to the lambdoid border, there is a small, shallow and evenly rounded defect measuring about 7.0mm. in diameter. The defect has regular margins and has no rim of reactive bone indicating that no healing was in process. From the radiographs, it can therefore be concluded that the defect in the left parietal bone of the Laetoli Hominid 18 cranium is of non-pathological origin and probably occurred during the process of fossilisation. The cause of the defect might have been a solid object, probably a pebble, that pressed at the site of the left parietal bone in the course of the fossilisation process.

Exposure factors (65kV, 5mA, 5x30s, 99cm. FFD) of KD 54T Kodak T film, fine focus.

PLATE 31

PLATE 32: Radiograph of the right parietal bone of the Laetoli Hominid 18 (Cerebral surface). Note, the vascular grooves for the branches of the right middle meningeal vessels. Three main vascular grooves are displayed. Two for the frontal branch of the right middle meningeal vessels can be seen to start at the antero-inferior angle of the right parietal bone and run upwards and anteroposteriorly towards the sagittal border giving out small branches as they do so. The other vascular groove for the parietal branch of the right middle meningeal vessels starts at the postero-inferior margin of the right parietal bone and runs upwards and posteriorly for a short distance but its course is inturrupted by bone breakage.

Exposure factors (65kV, 5mA, 5x30s, 99cm. FFD) of KD 54T Kodak T film, fine focus.

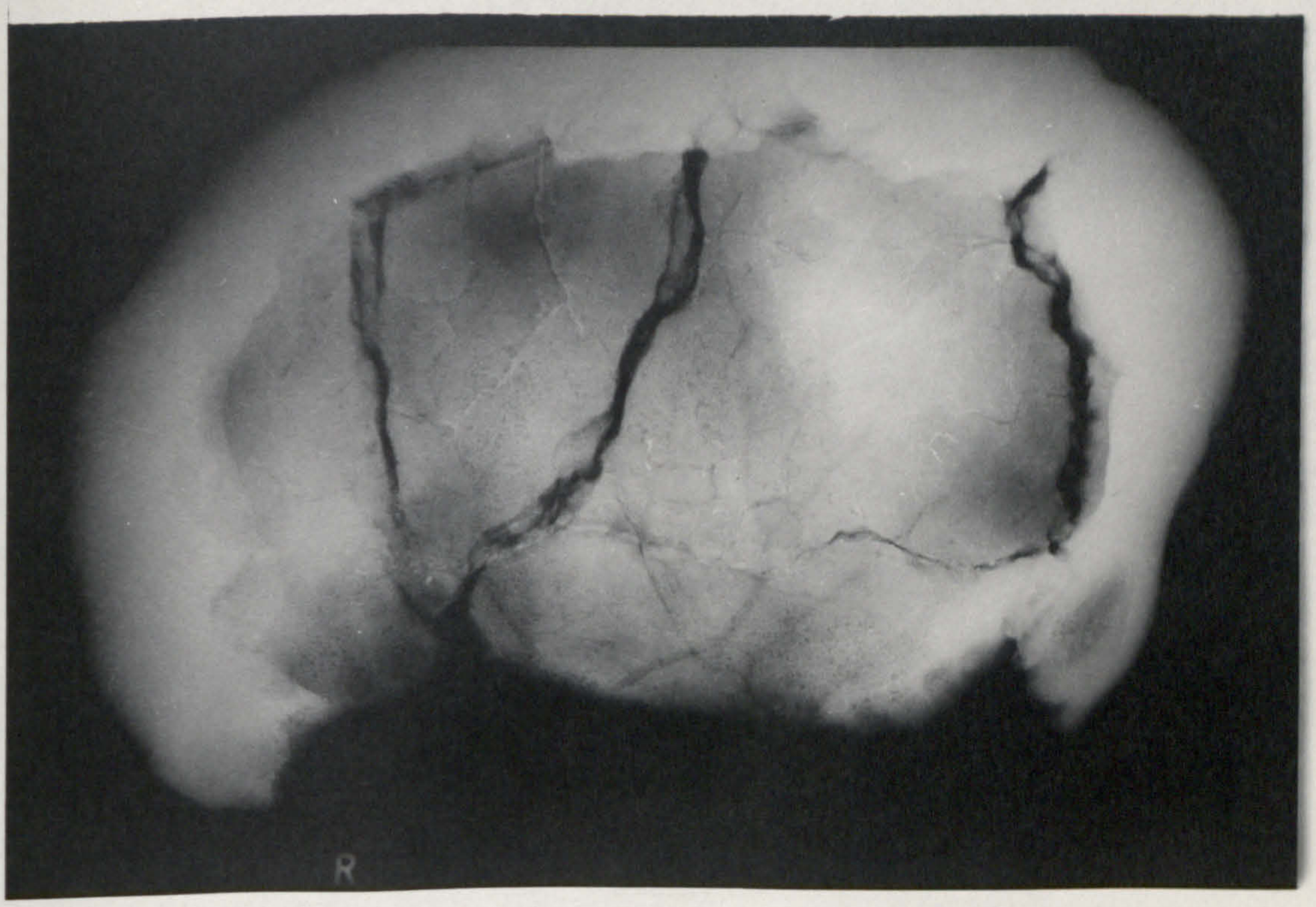


PLATE 32

PLATE 33: Radiograph of the maxillae of the Laetoli Hominid 18 cranium (Anteroposterior view). Note, the extent of the right and left maxillary air sinuses, the pear-shaped nasal aperture and the irregularly shaped alveolar margins. More of the left maxillary antrum is preserved than is the right and measures about 32.0mm. across, from the malar to the left lateral border of the nasal aperture. The left antrum extends upwards to the lower border of the orbit, here the bone is very thin. Laterally, the left antrum does not reach the maxillozygomatic suture. Unfortunately, the floor of the left antrum is not clearly shown, but certainly does not extend across the palate. The right maxillary antrum is only partially preserved, the floor is destroyed and as such, the extent of this antrum is not clearly defined. The palate is thick, the palatine suture is not fused and the nasal spine is preserved.
Exposure factors(65kV, 5mA, 5x=0s, 99cm. FFD) of KD 54T Kodak film, fine focus.

Plate 34A and 34B. Radiographs of the maxillae of the Laetoli Hominid 18 cranium (Left and Right lateral views) respectively, showing the teeth and the alveolar margins. On the left lateral view (Plate 34A), the preserved teeth include the root of P^4, M^1, M^2 and M^3. All the teeth are badly worn and the alveolar margin is badly damaged. The root of P^4 is broken off at the neck. The positions of the roots of the molar teeth are clearly shown in their relative sockets. The pulp cavities of the molars are visible. In M^1, the pulp cavity is visible in the crown and the anterior root extends at least as far as the alveolar margin. Very little enamel has remained on the tooth. In M^2, the pulp cavity appears to be reduced to a small cavity below the neck of the tooth and extends to canals in the roots. In the anterior root, the pulp cavity clearly extends to the tip of the root. The extent of the posterior root canal is concealed by the roots of the third molar tooth. M^3 appears to have a large pulp cavity reaching nearly to the worn occlusal surface of the tooth. The roots of M^3 are divergent and are not reduced, a root canal can be seen in the medial posterior root, extending nearly to the tip.

On the right lateral view of the maxillae (Plate 34B), P^3, P^4 and M^1 are preserved. As in the left lateral side, the teeth are very worn and the alveolar margin is badly damaged. The right lateral view also reveals the pronounced degree of sub-nasal prognathism. Due to the super-imposition of the teeth in this view, the detailed features are obscured.

As a whole, the radiographs show clearly that the teeth are not taurodant, a feature sometimes associated with the Neanderthal teeth.

Exposure factors (65kV, 5mA, 5x10s, 99 cm FFD) of KD54T Kodak film, fine focus.

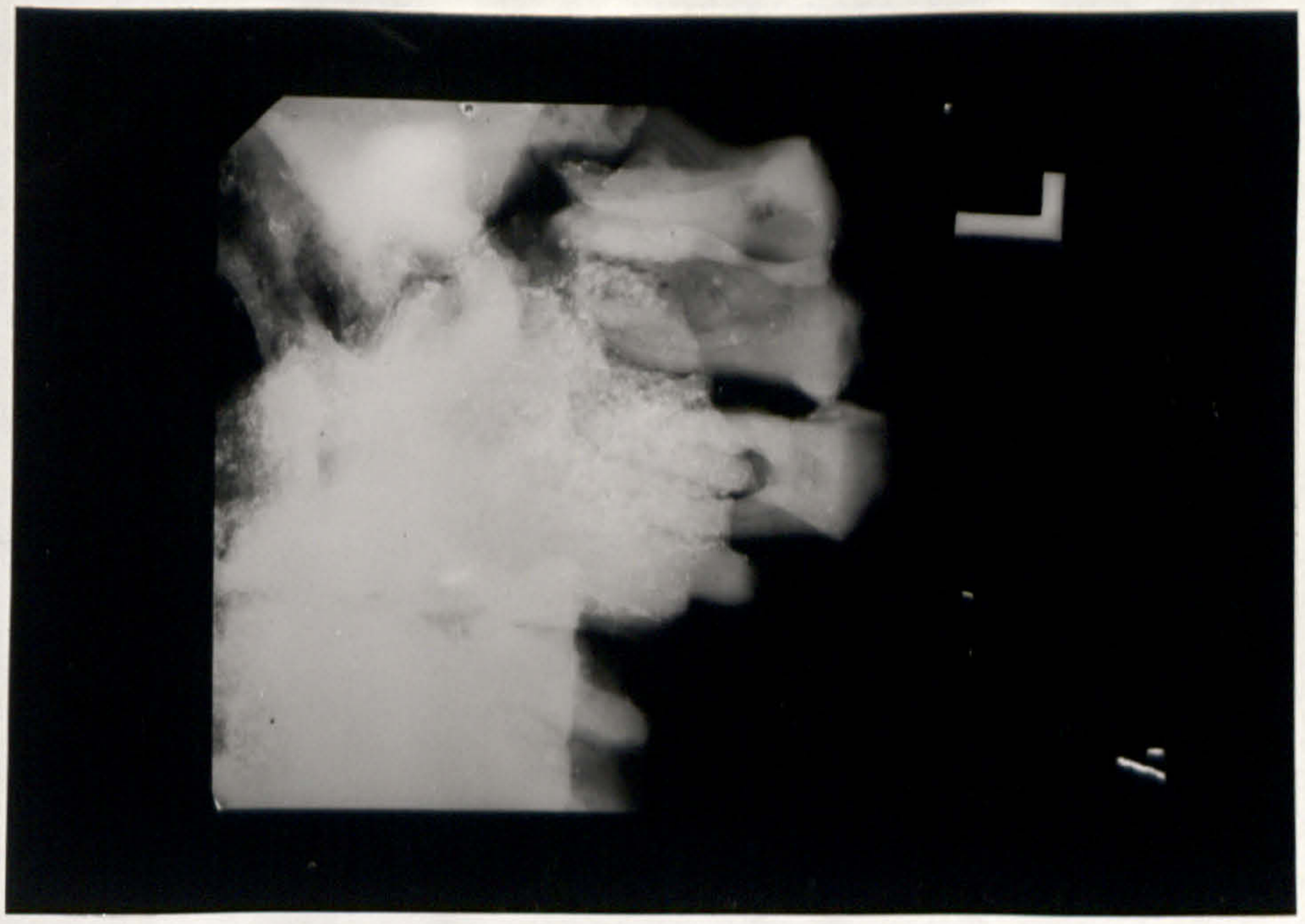


PLATE 34A

PLATE 34B

PLATES 35A and 35B: Radiographs of the right temporal bone of the Laetoli Hominid 18 (Basal and Inner surfaces) respectively. The squamous part of the right temporal bone is well preserved and thin walled although broken anteriorly. The tympanic part is only partially preserved. The internal auditory meatus is clearly shown but the tympanic antrum is badly damaged. There are no bone ossicles preserved and no indication of pathology. The petrous bone has not been penetrated by X-rays, so only little detail is visible. The mastoid process is not easily visible. There is pneumatisation of the posterior part of the bone that extends posteriorly to within about 4mm. of the asterionic margin. As a whole, the bone is highly pneumatised.

Exposure factors (65kV, 5mA, 5x10s, 99cm, FFD) of KD 54T Kodak film, fine focus.

PLATE 35A

PLATE 35B

PLATES 36A & 36B: Radiographs of the left temporal bone of the Laetoli Hominid 18 (Basal and inner surfaces) respectively. The squamous part of the temporal bone unlike that of the right side is poorly preserved. The internal auditory meatus is well shown but the tympanic antrum as well as the bone ossicles are not preserved. The foramen ovale and the foramen spinosum are visible. Like the right petrous bone, the left has not been penetrated by X-rays and thus little detail is visible. The mastoid process is not clearly visible. There is some degree of pneumatisation of the posterior part of the petrous temporal bone.

Exposure factors (65kV, 5mA, 5x1Os, 99cm. FFD) of KD 54T Kodak film, fine focus.

PLATE 36A

PLATE 36B

In the present study, attempts were made to X-ray the Laetoli Hominid 18 cranium so as to visualise the internal structures of the cranium as a whole, to demonstrate the presence and extent of a possible lesion in the left parietal bone, to verify the extent of the frontal and maxillary air sinuses and finally, to demonstrate the extent of the dental caries.

Normal medical radiographic techniques were used, employing non-screen film and separate radiographs of the calotte, temporal bones and maxillae, together with some teeth were taken. The exposure factors varied according to the areas examined.

(d) <u>The endocranial cast obtained from the Laetoli Hominid 18 cranium</u>

No natural endocranial cast was found with the cranial remains of the Laetoli Hominid 18 specimen. However, due to the excellent state of preservation of the calvaria as a whole, it was possible to obtain a reasonably complete mould of its interior.

The endocranial cast of the Laetoli Hominid 18 specimen is large and ovoid. The endocast presents an almost complete forebrain together with part of the cerebellum. The forebrain includes both the right and left cerebral hemispheres each comprising of the frontal, parietal, occipital and temporal lobes. As a whole, the external

surface of the endocast is irregular and presents with some impressions of the gyri and sulci of the cerebrum, the meningeal vascular markings, together with the markings caused by the numerous cracks of the vault bones. The impressions of the gyri and sulci are well preserved on the frontal region whereby the impressions of the superior and inferior frontal gyri, together with their corresponding sulci, are prominent. Relatively little modelling by gyri is preserved over the parietal, temporal, occipital and cerebellar lobes.

Viewed in norma frontalis (Plate 37) the anterior part of the endocranial cast is complete and divisible into right and left hemispheres by a longitudinal fissure. The position of the frontal pole is well indicated. The frontal lobe presents with well marked superior and inferior frontal gyri. The endocast is flattened anteriorly.

In norma lateralis (Plates 38 and 39) the endocranial cast is long and ovoid. On the right side, the lateral aspect of the parietal, occipital and temporal lobes are almost complete. Only the lateral aspect of the occipital lobe is complete on the left side. On both sides, the inferolateral part of the frontal lobe is missing. Almost all of the temporal lobe and a part of the parietal lobe are not represented on the left side.

The external outline of the endocranial cast reflects that observed on the interior aspect of the cranium. Thus, from the region of the frontal pole, the profile rises

PLATE 37: Norma frontalis of the endocranial cast of the Laetoli Hominid 18 cranium. Note the completeness of the anterior part of the endocranial cast; the endocranial cast is divisible into right and left hemispheres by a longitudinal fissure, the position of the frontal pole and the areas of the superior and inferior frontal gyri.

PLATE 38: *Right norma lateralis of the endocranial cast of the Laetoli Hominid 18 cranium. Note, the completeness of the parietal, occipital and temporal lobes, the vascular markings for the frontal and parietal branches of the right middle meningeal vessels.*

PLATE 38

PLATE 39: Left norma lateralis of the endocranial cast of the Laetoli Hominid 18 cranium. Note, the left side unlike the right is incomplete and lacks most of the temporal lobe. The pattern of the vascular markings is in general identical to that of the right side.

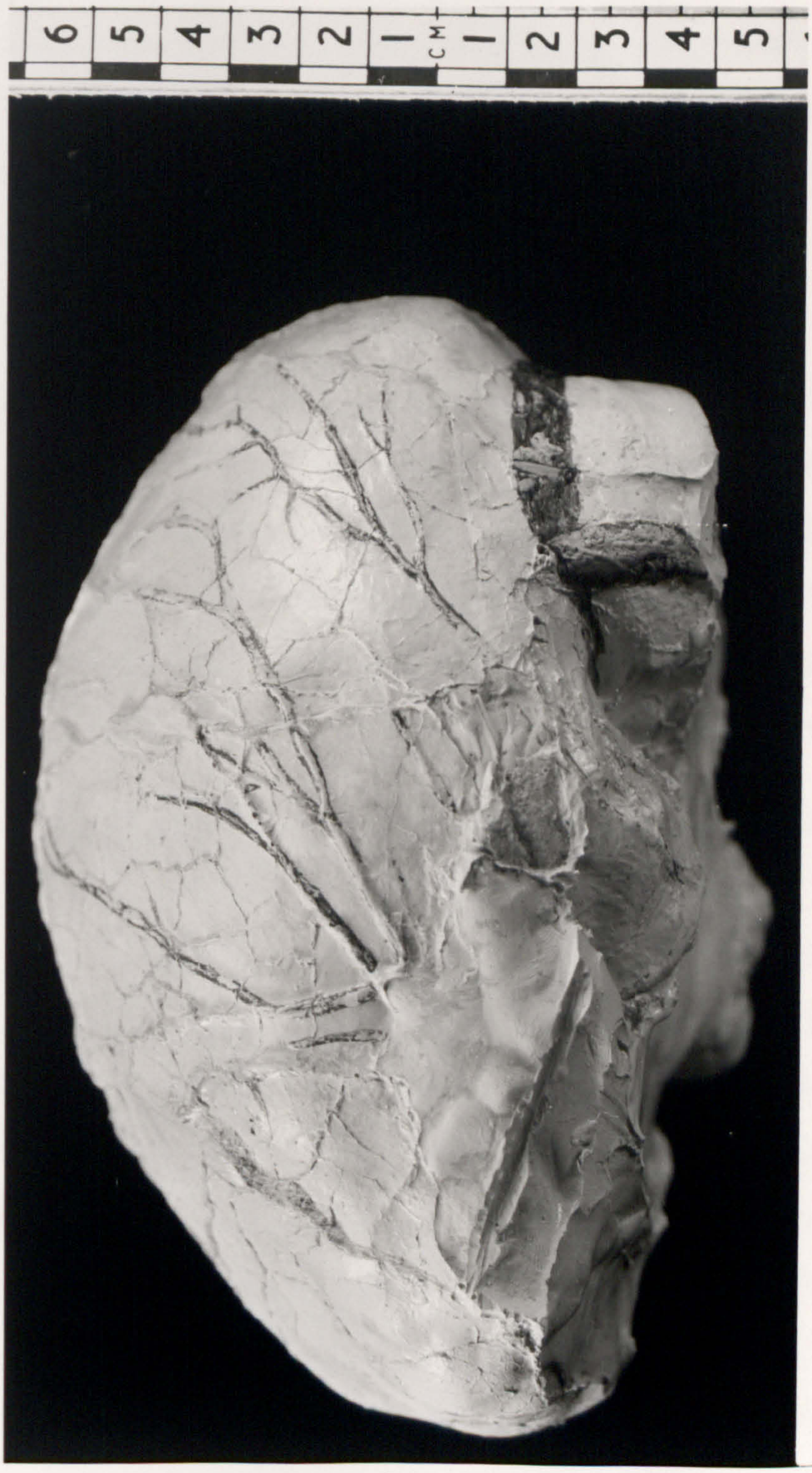


PLATE 39

steadily upwards and backwards then flattens for a short distance before reaching a maximum rise at the bregma. Posterior to the bregma the profile curves gently backwards to the mid-parietal region then flattens again for a short distance to the lambda. From the lambda the profile curves posteriorly acquiring the rounded profile of the occipital lobe before terminating at the occipital pole.

The lateral view of the endocast displays, in general form, symmetrical meningeal vascular markings on both sides. The basic pattern of the meningeal vascular markings on both sides comprises a common trunk at the inferior surface of the temporal lobe. At the region of the pterion, the common trunk divides into an anterior and a posterior trunk, each giving out several branches to supply the respective areas.

On the right side of the endocast, the middle meningeal vessels start at the inferior surface of the temporal lobe, then curve upwards on the anterior surface of the temporal lobe. At the region of the pterion, though the course of the middle meningeal vessels is obscured, the course of the frontal and posterior branches of the middle meningeal vessels is well marked. Thus, the frontal branch of the middle meningeal vessels very soon divides into an anterior and a posterior branch. The exact course and distribution of the anterior branch of the frontal branch of the middle meningeal vessels is difficult to determine. The posterior branch of the frontal branch of the middle meningeal vessels run vertically upwards on the

anterior surface of the parietal lobe and then divides into two smaller branches that can be traced as far as the mid-anterior aspect of the parietal lobe. The parietal branch of the middle meningeal vessels course backwards and upwards somehow parallel to the posterior branch of the frontal branch of the middle meningeal vessels. The parietal branch of the middle meningeal vessels unlike the frontal branch, gives out several branches that extend as far as to the lambdoid suture. The pattern of the meningeal vascular markings on the left side is basically similar to that on the right side.

In addition to the vascular markings, the lateral view further reveals a marked parietal eminence and a ridge caused by the superior parietal lobe. Due to the incompleteness of the endocast, it is difficult to allocate the exact positions for the speech and hearing centres.

In norma verticalis (Plate 40) the endocranial cast is again seen to be ovoid, elongated with marked impressions of the meningeal vascular markings. The superior and inferior frontal gyri, the parietal eminence, and the parietal ridge caused by superior parietal lobe are still remarkable features of this view. In addition, the endocast presents with a mid-line depression at the parieto-occipital region.

In norma occipitalis (Plate 41) the following features are clearly shown; the depression at the parieto-occipital region, a marked ridge caused by the lambdoid

PLATE 40: Norma verticalis of the endocranial cast of the Laetoli Hominid 18 cranium. Note, the elongation of the cerebral hemisphere, the position of the frontal pole and the extent of the distribution of the branches of the middle meningeal vessels.

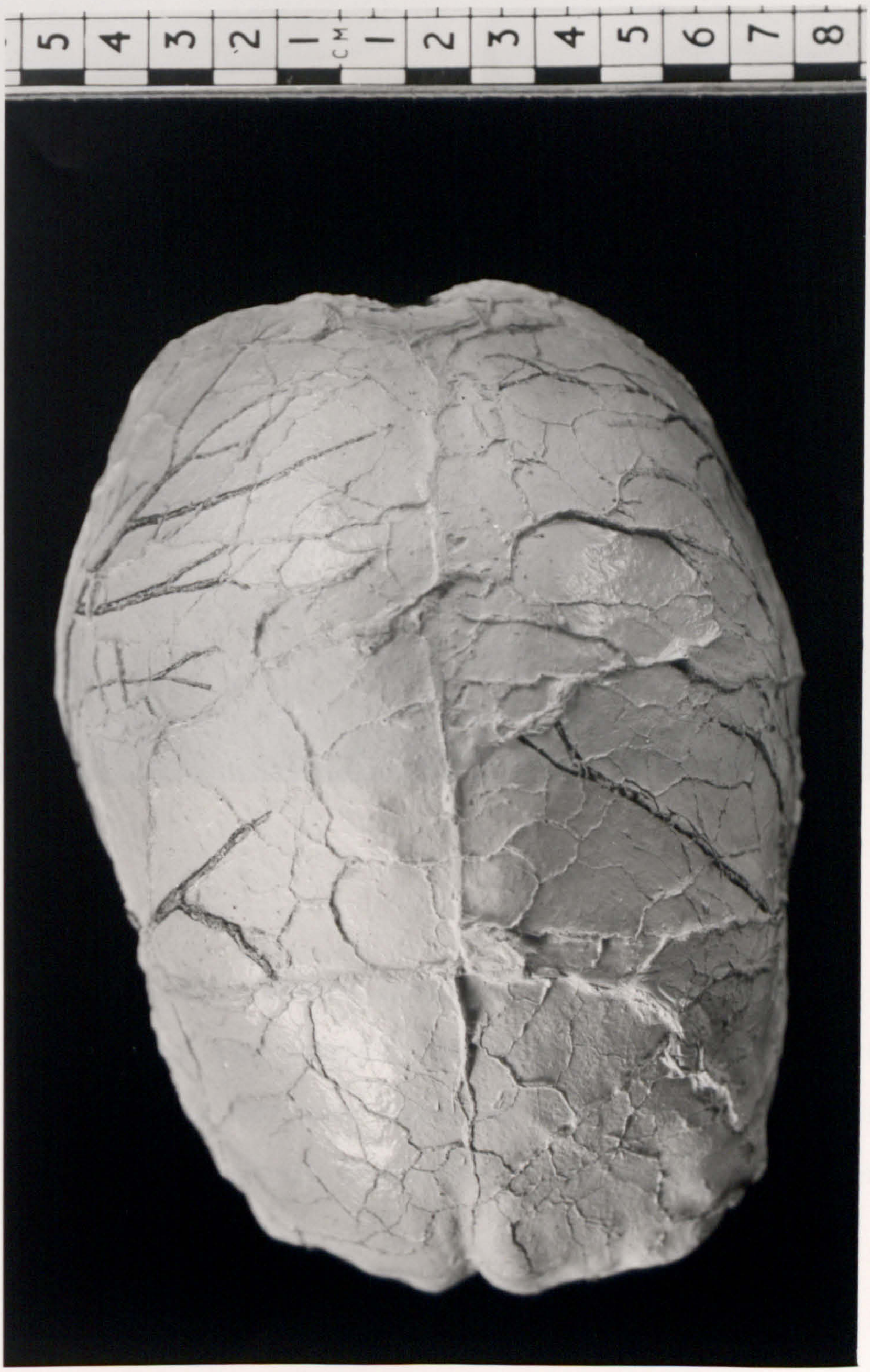


PLATE 40

PLATE 41: Norma occipitalis of the endocranial cast of the Laetoli Hominid 18 cranium. Note, the markings for the sagittal and lateral sinuses, the sagittal sinus directly joins the right lateral sinus.

PLATE 42: Norma basalis of the endocranial cast of the Laetoli Hominid 18 cranium. Note, the incompleteness of the basal surface, the right temporal lobe and pole, the frontal pole and the vascular markings.

PLATE 42

suture, the impressions of the lateral sigmoid and sagittal sinuses as well as of the occipital crest and the occipital poles of the cerebral hemispheres.

In norma basalis (Plate 42), in addition to those features already observed in norma occipitalis, the view also reveals the meningeal vascular markings on the inferior surface of the temporal lobes and part of the cerebellar hemispheres.

The cranial capacity of the Laetoli Hominid 18

The volume of the endocast of the Laetoli Hominid 18 was determined by the water displacement method after the cast had been varnished. The displaced water was measured by volume and in all 15 measurements were taken. The mean of these estimates was 1200 cc. This measurement is regarded as the cranial capacity of the Laetoli Hominid 18.

B. COMPARATIVE MATERIALS

In order to evaluate the position and taxonomic status of the Laetoli Hominid 18 cranium, comparisons with other hominid fossils and modern crania are necessary. The features of the Laetoli Hominid 18 cranium were compared with the corresponding parts of the better preserved crania from a number of other localities.

This study was conducted on either casts or original specimens as shown in Table 1. Most of the

TABLE 1. Groups of fossil hominids and Modern crania employed in the study

Group	Number	Specimen	Abbreviation	Cast/Original	Place of Storage
(1) Sub-Saharan early Upper Pleistocene	7	Kabwe Omo 1 Omo 2 Singa Florisbad Saldanha Eyasi 1	Ka. Om 1 Om 2 Si. Fl. Sald. Ey 1	Original Cast " Original Cast " "	B.M.(N.H.) S.T. S.T. B.M.(N.H.) " " " " " "
(2) Sub-Saharan later Upper Pleistocene	3	Iwo Eleru Fish Hoek Matjes River	Iw. Fi Mat.	Cast " "	B.M.(N.H.) " " " "
(3) Middle East early Upper Pleistocene	2	Tabûn 1 Amud	Tab. Am.	Original Cast	B.M.(N.H.) " "
(4) Middle East later Upper Pleistocene	2	Skhûl 5 Kafzeh 9	Skh 5 Kaf. 9	Cast Cast	B.M.(N.H. " "
(5) Pekin *Homo erectus*	4	Pekin Locus E2 Pekin Locus L1 Pekin Locus L2 Pekin Locus L3	PKLE 2 PKLL 1 PKLL 2 PKLL 3	Cast Cast Cast Cast	B.M.(N.H.) " " " " " "
(6) Far East/Australia Upper Pleistocene	3	Wadjak 1 Solo 1 Keilor 1	Wad'j Sol 1 Kel 1	Original Cast Cast	" " " " " "
(7) European early Upper Pleistocene	8	La Chapelle-aux-Saints La Quina V Le Moustier La Ferrassie Spy 1 Spy 2 Gibraltar 1 Swanscombe	Chap. Quin. V Moust. Fer. Sp. 1 Sp 2 Gib. 1 Swan.	Cast Cast Cast " " " " original	B.M. (N.H.) " " " " " " " " " " " " " "
(8) Laetoli Hominid 18 Cranium	1	Laetoli Hominid 18 Cranium	L.H.18	original	
(9) Sub-Saharan modern	24 53 39	Ngoni Ashanti Kaffir	Ng. Ash. Kaf.	Original " "	B.M.(N.H.)
(10) North African Upper Pleistocene	1	Djebel Irhoud	D.I.	Cast	B.M.(N.H.)
(11) Sub-Saharan *Homo erectus*	1	Olduvai Hominid 9	O.H.9	Cast	B.M.(N.H.)

comparative materials were made available for study by the British Museum (Natural History) or by the Department of Anatomy, St. Thomas' Medical School. A total of 31 hominid fossil crania were examined, including some original specimens such as the Kabwe, Singa, Tabun I, Wadjak I and Swanscombe skulls presently stored at the British Museum (Natural History). In addition, I was fortunate to make observations of the original specimens such as Olduvai Hominid 9 and 12, and the ER 3733 specimens stored in the Kenya National Museum in Nairobi.

Generally, the comparative hominid fossil crania used were satisfactory specimens apart from some deficiencies in certain areas. Re-constructed specimens such as the Florisbad and Eyasi I skulls were used with caution.

In addition to the hominid fossil crania mentioned above, a total of 116 sub-Saharan modern human crania were also examined and used as a reference group. The sub-Saharan modern crania were drawn from the Ngoni, Ashanti and Kaffir groups. Only the better preserved crania were chosen for examination from the collections. All of the sub-Saharan crania are presently stored in the British Museum (Natural History).

The comparative materials were divided up into eleven groups on the basis of their geographical distribution and supposed chronology. The groups as shown in Table 1, consist of: (1) sub-Saharan early Upper Pleistocene, (2) sub-Saharan later Upper Pleistocene, (3) Middle East

early Upper Pleistocene, (4) Middle East later Upper Pleistocene, (5) Pekin *Homo erectus*, (6) Far East/ Australia Upper Pleistocene, (7) European early Upper Pleistocene, (8) North African Upper Pleistocene, (9) sub-Saharan Modern and (10) sub-Saharan *Homo erectus*.

The comparative study required a brief description of each of the fossil skulls used and includes a short account of the stratigraphy, geology, faunal and archaeological context of each fossil with the dating usually given. The description of the materials follows the order of the groupings as listed in Table 1.

The following abbreviations have been used to indicate the present place of storage of the comparative materials.

1. B.M.(N.H.) British Museum (Natural History).
2. S.T. St. Thomas' Hospital, Department of Anatomy.
3. RCS Royal College of Surgeons
4. KNM Kenya National Museum, Nairobi

(i) <u>The sub-Saharan early Upper Pleistocene crania</u>

<u>Broken Hill (Zambia). Cranium. Original: B.M.(N.H.). E686</u>

The Kabwe skull previously known as Rhodesian Man or Broken Hill Man, was found in 1921 during lead mining operations. The skull was first described by Woodward (1921), and since then, its morphology has been detailed in a number of early publications.

The skull consists of an almost complete cranium only lacking the right temporal bone, right zygomatic process and parts of the occipital bone. The Kabwe cranium is heavily mineralized and is large. Seen from the front, the cranial vault is low, the facial skeleton is large with inflated maxillae lacking canine fossae; the maxillary frontal process, together with the walls below the orbits are relatively flattened; the palate is large with alveolar prognathism, the supraorbital torus, together with the glabella are massively developed while the frontal bone is narrow, markedly flattened in spite of some keeling. Laterally, the parietals are relatively flattened and the temporal fossae are deep. On the left, the temporal bone possesses two possible bone anomalies. Opinions have differed as to the nature of the left bone anomalies. Yearsley (1928) suggested that the cause of the anomalies was most likely to be due to a wound inflicted by some sharp instrument. This view was accepted by various authors like Piveteau (1957). McKenzie and Brothwell (1967) however, thought the mastoid anomaly in the temporal bone was most likely to be pathological. Wells (1964) suggested that the anomaly in the squamous temporal bone was probably due to erosion of the bone from a metastatic abscess. Recently however, Price and Molleson (1974) have concluded that there is no convincing evidence for disease in the middle ear or mastoid process of Broken Hill Man. The mastoid processes, together with the supramastoid crests, are well developed.

Posteriorly, the occipital bone is sloping, angulated and presents with a marked occipital torus.

The geology, stratigraphy, archaeological context, together with the dating of the Broken Hill cranium, has already been dealt with previously in the literature review.

Singa skull (Sudan). Calvaria. Original: B.M.(N.H.). M15546

The Singa calvaria was recovered by W.G.R. Bond in 1924 at Singa District of eastern Sudan (Oakley et al., 1977). The calvaria was first described by Woodward (1938). Very recently an account of the Singa calvaria has been written by Brothwell (1974).

The Singa calvaria consists of an almost complete and intact cranial vault lacking the maxilla, the whole of the right zygomatic arch, parts of the left zygomatic arch as well as the floor of the orbits on both sides.

The calvaria is heavily mineralised and with a low cranial vault. Viewed from the front, the supraorbital torus is broad and well developed. The frontal bone is flattened and presents with a shallow ophryonic groove. In the lateral view, the parietals are moderately flattened, laterally expanded with a prominent parietal bossing, together with an intra-parietal groove. There are no parietal foramina. The mastoid processes are small. Posteriorly, the occiput is evenly rounded with a slightly developed occipital torus.

An account of the geology, archaeological and faunal context, together with the dating of the material, has already been discussed in the review of the literature.

Florisbad skull. Cast: B.M.(N.H.) M 16959

The Florisbad skull was discovered in 1932 by T.F. Dreyer, Orange Free State, Republic of South Africa (Oakley et al., 1977). The skull, together with its associated culture and fauna, was first described by Dreyer (1935).

The Florisbad skull is incomplete and consists of a large part of the frontal, pieces of both parietals and incomplete right half of the face. From the preserved cranial bones, it can however be said that the Florisbad skull is large with a low cranial vault, revealing an intraparietal groove. Seen from the front, the supraorbital torus is well developed but does not form a continuous bar across the orbits. The orbits are low set with infra-orbital excavation, the nose is wide and the face is prognathous.

The geology, archaeological, fauna association, together with the dating of the Florisbad skull, has already been discussed in the literature review.

Saldanha skull. Cast: B.M.(N.H.) M17125

The Saldanha skull was discovered by Jolly in 1953 at Hopefield (Saldanha) (Oakley et al., 1977). The preliminary report about the skull was given by Drennan

(1953a) while Singer (1954), gave a detailed account of the skull.

The Saldanha skull when recovered was in many fragments and needed much restoration. The skull fragments, numbering over 20, when articulated together, fit nicely to one another to form an almost complete cranial vault.

The Saldanha skull is generally large and is characterised by a thickened cranial wall. Seen from the front, the cranial vault is low, the supraorbital torus, as well as the glabella, are well developed; the frontal bone is flattened and receding. From the sides, the parietal bones are relatively flattened and slope posteriorly towards the occiput with no apparent parietal bossing. Posteriorly, the occiput is sharply flexed and with an occipital bun. The occipital torus is moderately developed.

The geology, archaeological and faunal context, together with the dating of the Saldanha skull, has already been discussed in the literature review.

<u>The Omo skulls (Ethopia). Omo 1 cranium. Cast: S.T. EO 1. Omo 2 cranium. Cast: S.T. EO 2.1.</u>

The two Omo crania were discovered in 1967 by the Kenyan group of the International Omo Research Expedition (Leakey <u>et al</u>., 1969). A preliminary anatomical description of the crania has so far been given by Day (1969 and 1971). The Omo 1 cranium is a partially preserved cranial vault

consisting of parts of the frontal, parietals, occipital, right temporal and right zygomatic bones. Parts of the maxilla, mandible as well as two teeth crowns (right upper canine and left lower first molar) are also preserved. The cranial base and much of the foramen magnum are missing. The Omo 1 cranium is large and more lightly built than Omo 2. Seen from the front, the cranial vault, though low, is higher than that of Omo 2; the supraorbital torus and the glabella are well developed, the frontal bone is moderately flattened, receding and with a shallow ophryonic groove. In the lateral view, the parietals are moderately rounded from side to side and present with a pair of parietal foramina. From behind, the occipital bone is evenly rounded and presents with a moderately developed occipital torus.

Omo 2 cranium is more complete than Omo 1 and consists of an almost complete cranial vault. The entire face, as well as parts of the frontal bone, including the glabella and the right supraorbital region, are missing. All of the sutures are closed and part of the cranial base is missing. The Omo 2 cranium is also heavily built and with a lower vault than Omo 1. Seen from the front, the supraorbital torus is well developed, the frontal bone is flattened, receding and widened anteriorly. In the lateral view, the parietal bones are flattened, keeled and with parasagittal depressions, the mastoid processes, together with the supramastoid crests, are well developed; the tympanic bone is thickened while the zygomatic process of the frontal bone is stout. From behind, the occiput slopes

downwards and is angulated, ending up with a marked occipital torus; the nuchal muscle impressions are well marked and the occipitomastoid crests are developed. The base of the cranium reveals deep articular fossae with forward facing foramen magnum.

The geology, archaeological and faunal context, together with the dating of the Omo crania, has already been discussed in the literature review.

Eyasi I skull. Cast: B.M.(N.H.) M 16968.

The Eyasi I skull, together with Eyasi II and III, were recovered between 1935 and 1938 by Kohl-Larsen at Lake Eyasi, Tanzania (Oakley et al., 1977). The first report on the Eyasi I skull was given by Kohl-Larsen and Reck (1936). Recently, Protsch (1976) has made new morphological studies of the Eyasi I skull, based on a new reconstruction and using new dating methods.

The skull of the Eyasi I is very fragmentary and consists of the frontal, parietals and occipital bones. The maxilla, left temporal, together with isolated teeth, are also preserved. The Eyasi I skull is of moderate size and heavily mineralised. Seen from the front, the skull is low vaulted with well developed supraorbital torus; the frontal bone is flattened, receding and with no ophryonic groove. From the side the parietal, though flattened anteriorly, has a rounded profile posteriorly and some bossing; the mastoid processes are small. From behind, the occipital profile is well rounded with a moderately developed occipital torus.

The geology, archaeology and faunal association, together with the dating of the Eyasi I skull, has already been discussed in the literature review.

(ii) <u>The sub-Saharan later Upper Pleistocene crania Fish Hoek skull. Cast: RCS 3.81</u>

The Fish Hoek skull was discovered between 1927 and 1929 by V.S. and B. Peers from a Rock-shelter, Skildergat or Peers' Cave, Fish Hoek (Oakley <u>et al</u>., 1977). The skull was first reported by Keith (1931). It is well preserved and consists of an almost complete cranium, together with the mandible. It is a large skull with relatively high cranial vault. Seen from the front, the glabella, together with the supraorbital torus, are developed; the nasion is inserted into the glabella, the frontal bone is moderately flattened and presents with an ophryonic groove. From the side, the parietals are moderately rounded and slope posteriorly towards the occiput and are bossed; the mastoid processes are small. From above, the parietals present with interparietal grooves while the posterior view reveals a sloping occiput with moderately developed occipital torus.

The Fish Hoek skull was recovered from cave deposits (Keith, 1931) and was associated with Middle Stone Age Industry or Stillbay assemblages, together with fauna that includes *Equus capensis* (Dart, 1933). The dating of the Fish Hoek skull, on the basis of C^{14} dating methods on charcoal, is said to be about 36,000 $\pm$ 2,400 yr. B.P. (Protsch, 1975).

Matjes River skull I. Cast: B.M.(N.H.) EM 1285

The skull of a moderate size was discovered between 1930 and 1932 by T.F. Dreyer from a Rock-shelter, about 13 km north-east of Plettenburg Bay, Cape Province (Oakley et al., 1977). It was first described by Keith (1933).

The Matjes River skull I is almost complete. Seen from the front, the cranial vault is relatively high, the supraorbital torus, together with the glabella are developed, the frontal bone is well rounded, bossed and presents with an ophryonic groove. From the side, the parietals are flattened anteriorly but laterally expanded with parietal bossing, the mastoid processes are small. From behind, the occiput slopes downwards and has a moderately well developed occipital torus. From above, the parietals present with an inter-parietal groove.

The Matjes River skull was recovered from a sterile layer in occupational deposits (Layer E),(Keith, 1933). The associated culture is presumed to be contemporary with or just subsequent to, the Stillbay culture (Keith, 1933); there was no definite faunal association with the skull. The stratigraphical age of the Matjes River site is said to be within the Late Pleistocene/Holocene period (Oakley et al., 1977) while the absolute date on the basis of C^{14} is about 10,120 $\pm$ 2,000 (Protsch, 1975).

Iwo Eleru skull. Cast: B.M. (N.H.). EM 1413

The Iwo Eleru skull was discovered by Shaw in 1965 from a rock shelter 24 km from Akure, Western Nigeria (Oakley et al., 1977). The Iwo Eleru skull believed to be of an adult male, together with the post-cranial materials, were first described by Brothwell and Shaw (1971). The skull is mostly fragmentary and consists of most part of the calvaria including the frontal, parietal and occipital squama bones. Several teeth with the mandible are also preserved.

Seen from the front, the vault is low; the supra-orbital torus, together with the glabella are well developed; the nasion is situated below and at the same level as the glabella; the frontal bone is flattened with no ophryonic groove. From the side, the parietals are also flattened and laterally expanded with parietal bossing; the mastoid processes are small. From behind, the occipital bone is well rounded, filled and with a moderately developed occipital torus.

The site of the Iwo Eleru is a large rock shelter in the rain forest zone of Western Nigeria (Brothwell and Shaw, 1971). Associated with the Iwo Eleru skull were numerous Late Stone Age artefacts but no faunal remains have been reported (Brothwell and Shaw, 1971). The dating of the Iwo Eleru skull, based on a series of radiocarbon dates on closely associated charcoal, has been given as 11,200 $\pm$ 200 yrs B.P. (Shaw 1965 and 1968).

(iii) The Middle East early Upper Pleistocene crania

Tabūn I skull. Original: B.M.(N.H.)

The Tabūn I skull was discovered between 1929 and 1934 by a joint Anglo-American expedition directed by D.A.E. Garrod at the caves Mugharet et-Tabūn (Oakley et al., 1975). The skull has fully been described by McCown and Keith (1939). It is almost complete and consists of much of the cranial vault and lower parts of the face. Both zygomatic arches, left orbital region as well as the base of the cranium are missing. The mandible is represented by most of its body bearing some teeth while on the left side, the coronoid process is broken off as is the right ramus. Viewed from the front, the skull has a low cranial vault, the maxilla is large with a U-shaped dental arcade; the supraorbital torus and the glabella are well developed; the frontal bone though arched presents with a marked ophryonic groove. From the side, the parietal bones are flattened and laterally expanded with no apparent parietal bossing; the mastoid processes are small. From behind, the occipital profile is well rounded with a moderately developed occipital torus.

The geology, archaeological and faunal context as well as the dating of the Tabūn I skull has already been discussed in the review of the literature.

Amud I skull. Cast: B.M. (N.H.) E 1380

The Amud I skull was discovered in 1961 by the Tokyo University scientific expedition to West Asia directed by H. Suzuki (Oakley et al., 1975). The skull has been fully described by Suzuki and Takai (1970). It consists of great part of the vault; much of the base is missing as are most parts of the face. The mandible is intact. The Amud I skull is large and long. Seen from the front, the skull has a high cranial vault and presents with massively developed supraorbital torus and glabella; the frontal bone is slightly keeled and receding with no apparent frontal bossing. Seen from the side,. the parietals are flattened and laterally expanded. The skull is widest at the mastoid crests; the mastoid processes are large. From behind, the posterior view reveals a rounded occipital bone with moderately developed occipital torus. The dental arcade is U-shaped.

The deposits from the cave site from where the skull was discovered consist of Upper Cretaceous and Eocene limestones, the upper part of which is exposed in the lower part of the Amud gorge. The limestone layer has been divided into four strata from above downwards; Massive limestone, Bedded limestone, Weakly Bedded limestone and Irregular Bedded limestone. The Amud cave opens between the Massive and Bedded layers. The cave deposits consist of two layers, A and B. Layer A is recent while layer B is made up of loose calcareous silts with limestone rubble and comprises of (1-4) strata. The Amud I skull

was found as a contracted burial below the top of layer B1.

The Amud I skull was associated with a single industrial cycle consisting of a mixture of Levalloiso-Mousterian and Upper Palaeolithic stone tools. Few mammalian remains were associated with the skull and included *Dama mesopotamica*, *Bos sp.*, *Sus sp.*, *Capra sp.* and *Equus sp.*

The dating of the Amud skull is mainly based on the faunal and archaeological associations supported by physical methods of dating. Thus, from the faunal and cultural association, the Amud I skull is attributed within the Interstadial, between the Early and Main Fourth Glaciation (Würm). This is supported by the uranium/ionium growth which gives a date of 27,000 ± 500 years B.P. and the uranium fission track which gives a date of 28,000 ± 35% years B.P. (Suzuki and Takai, 1970).

(iv) The Middle East later Upper Pleistocene hominid crania

Skhūl V skull. Cast: B.M. (N.H.) M 1664

The Skhūl V skull was discovered between 1929 and 1934 by a joint Anglo-American expedition directed by D.A.E. Garrod at the cave Wadi el-Mughara (Oakley et al., 1975). The skull has been fully described by McCown and Keith (1939). It consists of an intact cranial vault, lower part of the maxilla, lateral wall of the right orbit and much of the cranial base. The whole of the

mandible including the teeth is also preserved. The skull lacks in portions of the nasal bones, together with the middle part of the face. The Skhūl V skull is large with a relatively high cranial vault. Viewed from the front, the supraorbital torus together with the glabella are well developed, the position of the nasion is well below and behind the glabella, the frontal bone is moderately arched and with a marked ophryonic groove. From the side, the parietals are well rounded from side to side and the mastoid processes are large. Posteriorly, the occipital profile is rounded with a moderately developed occipital torus.

The geology, archaeology, faunal association together with the dating of the Skhūl V skull has been discussed in the literature review.

Djebel Kafzeh 9 skull. Cast: B.M. (N.H.) EM 2027

The skull was discovered in 1969 by B. Vandermeersch from a cave 2.5 km from Nazareth, on the south-west flank of mount Kafzeh Israel (Oakley et al., 1975). The skull is incomplete, less preserved and consists of an almost complete cranium with a face. The cranial base is only partially preserved. The Djebel Kafzeh 9 skull is long with a relatively high cranial vault. Seen from the front, the supraorbital torus as well as the glabella are well developed, the frontal bone presents with a marked ophryonic groove. From the side, the parietals are rounded from side to side and the occipital region is well filled

and possesses a slight torus.

The Djebel Kafzeh cave is large and deep. In all 24 layers have been identified and described including breccias, stalagmitic layers and limestone layers of differing colours, that have been numbered I-XXIV from above downwards. The Djebel Kafzeh 9 skull was discovered from level XVII, of Vandermeersch (1966) consisting of breccia and lumps of limestone. Also recovered from the Djebel Kafzeh cave were stone tools of Levalloiso-Mousterian type (Ronen and Vandermeersch, 1972). The fauna association include *Equus sp.*, *Rhinoceros sp.*, *Dama sp.*, *Bos sp.* and *Gazella sp.* (Vandermeersch, 1966 and 1970).

The precise date of the Djebel Kafzeh cave has so far been difficult to establish. On the basis of the fauna and geology the date of the site has been given as the Last Pluvial of the Würm Glaciation (Vandermeersch, 1966). Howell (1959) suggested the date to be as the end of the Last Interpluvial of the Würm Glaciation.

(v) The Pekin *Homo erectus* (Lower Cave)

Four casts of the Pekin *Homo erectus* crania were available for this study and are described below.

Skull II from Locus E. Cast: B.M. (N.H.) M 16819

The skull consists of an almost complete cranium with well preserved frontal bone together with supraorbital structures, both parietals, occipital squama, both

temporals including portions of the greater wing of the sphenoid bone on both sides. The base of the cranium is only partially preserved and the sutures are still open.

The skull is heavily built and low vaulted. Seen from the front, the supraorbital torus is well developed and presents with a depression in the mid-line, the frontal bone is arched, moderately bossed, receding and with pronounced post-orbital constriction. From the side, the parietals are flattened and slightly bossed posteriorly, they slope towards the occiput; the squamous part of the temporal bone is elongated and unarched, the tympanic region is heavily built while the mastoid processes are small. Seen from behind, the skull is widest at the asterionic region, the occipital squama is angulated and presents with a massive occipital torus. The basal view reveals deep but narrow glenoid fossae.

Skull I from Locus L. Cast: B.M.(N.H.) M15716

The skull is less preserved than skull II from Locus E. It consists of a greater part of the calvarium, parts of the frontal bone including the supraorbital structures, both parietals, occipital squama and parts of the right temporal bone. Most of the cranial base is missing.

Skull II from Locus L. Cast: B.M.(N.H.). M 15717

The skull is better preserved than skull I from Locus L and consists of the frontal, both parietals,

occipital, both temporals as well as a portion of the greater wing of the sphenoid bone on the left side. Parts of the foramen magnum are also preserved.

Skull III from Locus L. Cast: B.M. (N.H.). M 15718

The skull is the most well preserved from Locus L. It consists of parts of face, frontal, both parietals, occipital squama, left temporal as well as parts of the greater wing of the sphenoid on the left side. Parts of the foramen magnum are also preserved.

The three crania from Locus L present with almost similar morphological features to that of Skull II from Locus E though the former are larger skulls. The preserved parts of the facial bones in the skulls from Locus L, reveal features of low set orbits, high malar bones, projecting maxilla with wide and high palate.

The stratigraphy, dating, cultural and faunal associations of the Pekin skulls have already been dealt with under the literature review.

(vi) Far East/Australia Upper Pleistocene crania

Wadjak I skull. Original: (No registration), B.M.(N.H.)

The skull was discovered by B.D. van Rietschoten, 1889, near Tulungagung, Central Java, Indonesia (Oakley et al., 1975). It consists of an almost complete cranial vault with most parts of the face including the maxilla,

the whole of the frontal bone, right parietal, anterior part of the left parietal and parts of the occipital squama. A large part of the cranial base is also preserved.

The skull was first reported by Dubois (1890). It is a large skull and long. Seen from the front, the skull has relatively high cranial vault, the supraorbital and the glabella are moderately developed, the position of the nasion is below and slightly behind the glabella. The nose is saddle-shaped, the frontal bone is slightly flattened with no ophryonic groove and no keeling. From the side, the parietals are relatively rounded from side to side with slight parietal bossing, the mastoid processes are large. From behind, the occiput is moderately rounded with slight occipital torus.

The geology, archaeology, fauna and the dating of the Wadjak I skull have already been discussed in the literature review.

The Solo Skulls:

Solo skull number I. Cast: B.M.(N.H.) M 15726

A cast of Solo skull number I was available for study. The Solo 1 skull was first described by Oppenoorth (1932a and 1932b), later description was by Weidenreich (1951). The Solo I skull consists of an almost complete cranial vault mainly preserved on the right side. On the left side, parts of the frontal, parietal and temporal bones are missing. Most of the

occipital bone, as far as the posterior margin of the foramen magnum, is intact but the rest of the cranial base is missing.

Solo I skull is low vaulted with thickened cranial wall. Viewed from the front, the supraorbital torus and the glabella are well developed, the frontal bone is markedly flattened, keeled, receding and with a shallow ophryonic groove. From the side, the parietals like the frontal bone are flattened and keeled, the mastoid processes are well developed. Posteriorly, the occiput slopes downwards and ends up at an angle with a marked occipital torus.

The stratigraphy, dating, faunal as well as cultural associations have already been dealt with under the section of the literature review.

Keilor I skull (Australia)

Skull. Cast: B.M. (N.H.) EM 235

The skull was discovered in 1940 by J. White at Keilor (Oakley et al., 1975). Its anatomical description was reported by J. Wunderly (1943). The Keilor I skull consists of most part of the cranial vault, together with the maxilla. Much of the cranial base mainly on the left side is preserved. The skull is long with a relatively high cranial vault. Seen from the front, the cranial vault is moderately high, the supraorbital torus, together with the glabella, are well developed. The position of the nasion is below and slightly behind the

glabella, the nose is saddle-shaped. The frontal bone is relatively rounded with some degree of frontal bossing and there is no frontal keeling nor ophryonic groove. From the side, the parietals are evenly rounded from side to side and present with parietal bossing, the mastoid processes are large. From behind, the occipital profile is rounded and has a moderately developed occipital torus.

The Keilor site consists of Doutta Galla Silt, below a diastem or minor disconformity. The skull probably came from B horizon of palaesol (1-2 ft) below the diastem (Gill, 1953). No archaeological association has yet been reported and the only faunal association were two vertebrates of *Macropus* (Gill, 1955).

On the geological evidence, the age of the Keilor I skull is probably within the Late Pleistocene period (Mahony, 1943).

(vii) <u>The European early Upper Pleistocene crania La Chapelle-aux-Saints skull. Cast: B.M.(N.H.) E 629</u>

The skull was discovered in 1908 by A. and J. Bouyssonie and L. Bardon near the village of La Chapelle-aux-Saints, 25 miles south east of Brive, Correze, France (Oakley <u>et al</u>., 1971). Detailed descriptions of the skull have been reported by Boule (1911-1913).

The La Chapelle-aux-Saints skull is almost complete with a well preserved base. Only small portions of the maxilla, mandible, left parietal and sphenoid bones are missing. It is a large skull. Seen from the front, the supraorbital torus, together with the glabella are markedly developed, the position of the nasion is well below and behind the glabella; the frontal bone is flattened and receding. Laterally, the cranial vault is low; the parietals are flattened and slope posteriorly towards the occiput. The mastoid processes are small while the occipitomastoid crest is well developed. Posteriorly, the occipital bone protrudes into a characteristic bun-shape with a centrally limited occipital torus.

The geology, archaeological, faunal association, together with the dating of the skull have been discussed in the review of the literature.

<u>La Quina I skull. Cast: B.M. (N.H.) EM 293</u>

The La Quina skull was discovered in 1911 by Martin in a rock-shelter (Oakley <u>et al</u>., 1971). It was first reported by Martin (1911) and is almost complete and lacks only parts of the upper face and the anterior portion of the cranial base. La Quina I skull is large with thickened walls. Seen from the front, the supraorbital torus and the glabella are well developed; the frontal bone presents with a marked ophryonic groove and is flattened, keeled and receding but with slight bossing. Laterally, the parietal bones are expanded and slope backwards towards

the occipital region. Posteriorly, the occiput protrudes backwards and presents with a marked occipital torus.

The La Quina I skull was discovered in Bed 3 layer consisting of greenish sandy clay deposits (Martin, 1912). Associated with the skull were numerous artifacts attributed to Mousterian Industry, together with faunal remains. The fauna included, *Elephas primigenius*, *Ursus spelaeus* and *Bos primigenius*, indicating a cold environment. The dating of the La Quina I on the basis of the fauna and archaeological evidences is within the Würm period (Oakley et al., 1964). Recently, ApSimon (1980), it has been shown that a number of Neanderthal finds including La Quina, date from the later sub-stage (Würm II).

Le Moustier skull. Cast: B.M.(N.H.) M 16899

The skull was found in 1908 by a Swiss antiquarian dealer (Hauser) in the terrace of the Le Moustier rock (Oakley et al., 1971). The discovery of this skull caused much controversy among the earlier workers due to lack of stratigraphical evidence of the site of the discovery. Different views as to the affinity and features of the skull were expressed by earlier workers; while earlier reconstructions of the specimen were inaccurate and misleading. In the present study, a cranial cast of Weinert's reconstruction was used.

The Le Moustier skull is believed to be of an adolescent boy; it is large and with thickened walls.

Seen from the front, the supraorbital torus, together with the glabella are moderately developed; the frontal bone is relatively flattened, bossing and presents with an ill-marked ophryonic groove. From the side, the parietals are rounded from side to side and laterally expanded, the mastoid processes, together with the supramastoid crests are well developed. From behind, the occipital profile slopes downwards and is angulated ending up with a moderately developed occipital torus.

The Le Moustier I skeleton was deliberately buried and probably lay in Bed J (Bordes, 1959). Associated with the skeleton were numerous artifacts attributed to Mousterian culture, together with faunal remains, including *Equus sp.* and *Rangifer tarandus*. On the faunal and archaeological evidences, the Le Moustier skull is attributed to the first stadial of the last glaciation. As reported by ApSimon (1980), the Le Moustier, date from the later sub-stage (Würm II).

La Ferrassie I skull. Cast: B.M.(N.H.) M 16807

The skull presumably of an adult male, was discovered in September, 1909 by D. Peyrony and L. Capitan in a rock-shelter, Savignac du Bugue (Oakley et al., 1971). The skull was initially described by Boule (1911-1913) and Heim (1968, 1970 and 1974) has given a detailed account of the skull.

La Ferrassie I skull is almost complete and intact, together with some teeth. The skull is large with thickened

walls. Seen from the front, the supraorbital torus is well developed with stout ridges, the glabella is prominent, the frontal bone is flattened, receding and with a slight ophryonic groove. From the side, the parietals are flattened and laterally expanded; the mastoid processes are small and the supramastoid crests are developed. From behind, the occiput is protuberant and slopes downwards, ending up with a marked occipital torus. The basal view of the skull reveals a broad hard palate with parabolic dental arcade, the mandibular notches are deep and large and all of the teeth are badly worn.

The geology, archaelogy and faunal association of the La Ferrassie I skull has been already discussed in the literature review.

Spy I and Spy II skulls

The two Spy skulls were discovered in 1886 by M. Lohest and M. de Puydt, in the Spy cave in the province on Namur, Belgium (Oakley et al., 1971). The two skulls were originally described by J. Fraipont and M. Lohest (1887).

Spy I skull. Cast: B.M.(N.H.) E 276

The skull consists of an almost intact, but damaged, cranial vault. Much of the temporal, together with the sphenoid, bones are missing. Spy I skull is large with relatively low vault. Seen from the front, the glabella and the supraorbital torus are massively

developed, the frontal bone though slightly bossing presents with an ophryonic groove. The position of the nasion is well below and behind the glabella. From the side, the parietal bones are keeled and slope downwards, posteriorly towards the occiput. Posteriorly, the occipital bone is moderately rounded with a marked occipital torus.

Spy II skull. Cast: B.M. (N.H.) E 278

Spy II skull consists of an almost complete calvaria. It is large with slightly higher cranial vault than Spy I. Viewed from the front, the supraorbital torus, together with the glabella are well developed; the frontal bone like in Spy I skull is slightly bossing and presents with an ophryonic groove. From the side, the parietals are markedly flattened and laterally expanded. Posteriorly, the occiput is angulated with a marked occipital torus.

The Spy skeletons were found in a cave deposit together with an extensive cold fauna including, *Elephus primigenius*, *Ursus spelacus* and *Bos primigenius*, together with dressed flints of Mousterian industry (Fraipont and Lohest, 1887). The date of this site has not been determined accurately. Zeuner (1940) suggested that the skeletons were laid down in the early part of the cold phase of Würm I. On geological, archaeological and faunal evidences however, Oakley (1964) believes that the site may be attributed to glaciation, and may date from between 35,000 to 75,000 yrs B.P.

Gibraltar I cranium. Original: B.M.(N.H.)

The Gibraltar I cranium was discovered in 1848 from the bone-breccia of Forbes's Quarry at Gibraltar (Oakley et al., 1971). It was first reported by G. Busk (1865) and its anatomical description was by P. Broca (1869).

The Gibraltar I cranium is only partially preserved. The face, together with the frontal and squamous occipital bones are intact. Most of the left as well as the central parts of the cranium are missing. The base is only presented by the anterior part of the basicranium, the foramen magnum is totally missing.

The Gibraltar I cranium is low vaulted with thickened cranial walls. Seen from the front, the supraorbital torus, together with the glabella are well developed; the frontal bone is flattened, receding and presents with an ophryonic groove. From the side, the preserved portion of the parietal bone indicates a flattened and non-bossing profile of the parietal bones. The mastoid processes are small. From behind, the occiput is evenly rounded and presents with a small occipital torus.

The geology of the site was reported by Busk (1865) to consist of calcreted sand, probably part of limestone breccia. No artifacts or mammalian bones were recovered with the skull and the precise site of the discovery is unknown. However, the Gibraltar I cranium has been thought to be contemporaneous to the juvenile skull, later discovered at Devil's Tower associated with

Mousterian implements (Garrod et al., 1928). Oakley (1964) has suggested the age of the Gibraltar I cranium to lie between 45,000 and 70,000 yrs B.P.

Swanscombe skull bones. Original: B.M.(N.H.) M 15709

The Swanscombe skull bones were discovered by A.T. Marston, 29 June 1935 and March 1936; Mr. and Mrs. B.O. Wymer, A. Gibson and J. Wymer, 30 July 1955 (Oakley et al., 1971). The skull bones consist of an occipital (1935), a left parietal (1936) and a right parietal (1955). The occipital and the left parietal bones were first studied by the Swanscombe committee (Morant et al., 1938). A complete account of the Swanscombe site, together with the fossil remains, was edited by Ovey (1964).

The three Swanscombe skull bones are almost complete and well preserved. The bones articulate together nicely. The sutures are open and the muscular markings are weak; it is believed that they belong to a young adult. The parietals are thickened but well rounded from side to side and are bossing. The temporal lines are well separated from each other and pass below the parietal eminence. The occipital bone is well rounded and presents with a small central limited occipital torus. The internal surface of the parietal bones reveals a complex meningeal vascular pattern in comparison with modern skulls while the grooves for the dural venous sinuses are asymmetrical.

The geology, archaeology and associated fauna as well as the dating of the Swanscombe skull bones have already been discussed in the literature review.

(viii) The North African Upper Pleistocene crania

Djebel Ighoud skull. Cast: B.M.(N.H.) 1805.

The Djebel Ighoud skull I was discovered in 1961 by workmen in the Djebel Ighoud barytes mind (Oakley et al., 1977). The skull has been investigated by E. Ennouchi (1962). The skull consists of an almost complete cranium with parts of the maxilla. Both zygomatic processes are broken. It is a long, large and with low cranial vault skull. Seen from the front, the supraorbital torus together with the glabella are massively developed; the frontal bone is flattened and keeled in the mid-line and presents with an ophryonic groove. From the side, the parietals are rounded and bossing and the mastoid processes are small. From behind, the occiput is angulated and with a small occipital torus.

The geology, archaeology and faunal association, together with the dating of the Djebel Ighoud I skull have been discussed in the literature review.

(ix) Sub-Saharan modern group

A total of 116 sub-Saharan modern crania were examined in this study. This sample was drawn from the

Ngoni, Ashanti, and Kaffir groups presently stored in the British Museum (Natural History). Attempts were made to obtain samples of modern crania from East Africa but this was difficult as there were no such suitable collections. The majority of the sub-Saharan modern crania are believed to be victims of tribal wars, as such, nearly all were likely to be crania of adult males. In this study, only the complete and well preserved crania were examined. The total number of crania in the three groups is shown below.

The Ngoni group

This group consisted of 24 crania all believed to be war hostages and were slaughtered by Mponda in "Nyasaland", now Malawi. These crania were presented to the British Museum (Natural History) by Sir Harry Johnston in 1892.

The Ashanti group

This group consisted of 53 crania from West Africa (Nigeria). These crania are also believed to be victims of tribal wars in Nigeria and were donated to the British Museum (Natural History) by the Oxford Museum in 1955.

The Kaffir group

This group consisted of 39 crania mostly believed to be Zulu warriors and were presented to the British Museum (Natural History) by the Royal Artillery Institute, Woolwich in 1911.

In this study, the three groups of the modern crania were treated as one main group representing the sub-Saharan modern *Homo sapiens* crania.

(x) The sub-Saharan *Homo erectus* crania

Olduvai Hominid 9. Calvarium. Cast: B.M.(N.H.) EM 596

The Olduvai Hominid 9 cranium was discovered in 1960 by M.D. Leakey at the Olduvai Gorge, Tanzania (Oakley et al., 1977). The discovery of the cranium was first announced by L.S.B. Leakey (1961) and brief comments on the cranium have since been published by Heberer (1963) and Tobias (1968). Recently Rightmire (1979) has extensively described the Olduvai Hominid 9 cranium.

The Olduvai Hominid 9 cranium consists of a partially preserved calvaria including the supraorbital structures. The right side of the vault is missing. The cranial base is almost intact. The Olduvai Hominid 9 cranium is heavily built and with a low cranial vault and thickened walls. Seen from the front, the supraorbital torus, together with the glabella, are massively developed. The frontal bone is markedly narrow, flattened, receding and presents with a marked ophryonic groove. From the side, the parietals like the frontal bones, are markedly flattened and gradually slope posteriorly towards the occiput; the mastoid processes are large and the supra-mastoid crests are well developed; the tympanic region presents with a large oval tympanic opening. Posteriorly,

the occipital bone is angulated and has a marked occipital torus.

The bone pieces of the Olduvai Hominid 9 cranium were found in the upper part of Bed II at site LLK in the smaller Side Gorge. The geology of the Olduvai area has been described in detail by Hay (1963 and 1976). No direct cultural association is attributed to the Olduvai Hominid 9 cranium. However, several quartz flakes and other tools were recovered from the excavations at the site of the Olduvai Hominid 9 and for a while the cranium was referred to as 'Chellean Man' (Rightmire, 1979). It is now known that both Developed Oldowan and Acheulian assemblages occur in Bed II (Leakey, 1971a and 1975). The mammalian fauna of the upper Bed II consists of numerous giant herbivores including *Hipoppotamus gorgops, stylochoerus nicoli, Mesochoerus olduvaiensis, Potamochoerus majus, Pelorovis olduwayensis* and *Equus oldowayensis*.

The dating of the deposits from the upper part of Bed II has been difficult, as potassium/argon age determination from tuff samples has mostly proved unreliable (Rightmire, 1979). However, the age estimation of Bed II has been based on magnetic polarity and is estimated to be between 1.7 to 1.15 m.y. B.P. (Hay, 1976).

IV. METHODS

The methods used in the study of Laetoli Hominid 18 cranium are considered under the following headings:

A. Cleaning and development.

B. Reconstruction.

C. Osteometry.

D. Statistical analyses.

A. CLEANING AND DEVELOPMENT

The cleaning and development of the Laetoli Hominid 18 cranium was done in the Department of Anatomy, St. Thomas' Hospital Medical School, London. This was a long and tedious process that required painstaking care.

Initially, before cleaning, all the fossil bone fragments had retained the characteristic matrix of the Ngaloba Beds from where they had been recovered. Thus, the surfaces of the fossil bones were rough and impregnated with an adherent matrix that included a calcretion of sand and clay, giving the physical appearance of a blackish-grey colour. The texture of the broken fossil bones looked chalky.

The process of cleaning was facilitated by the use of diluted acetic acid 3% concentration. The 3% concentration of the acetic acid was chosen after a series of initial trials of different concentrations of the acid on minute

fossil bone fragments that possessed neither clear anatomical features nor could fit in the reconstruction of the Laetoli Hominid 18 cranium. After a series of trials, it was found that at 3% concentration, the acetic acid would safely react and dissolve most of the adherent matrix from the surfaces of the fossil bone fragments and yet caused no damage nor erosion to the fossil bones themselves. This method of cleaning by the use of diluted acetic acid was found to be more convenient and safer than the use of an air-powered miniature jack-hammer.

Each individual fossil bone fragment was cleaned separately. The process of cleaning first involved the immersion of the fossil bone fragment into a glass jar containing the 3% acetic acid. Five minutes after the immersion of the fossil fragment into the acid, a series of bubbles were formed, first on the surface of the fossil fragment and later, the bubbles rose to the surface of the solution. While this process was taking place, the insoluble matrix separated from the fossil bone fragment and settled at the bottom of the glass jar. To ensure a thorough cleaning and without causing damage or erosion to the fossil bone fragment, at intervals of about ten minutes, the fossil bone fragment was removed from the acid media, its surfaces were then brushed and examined with a hand lens and dissecting microscope. As most of the fossil fragments were coated with matrix, it was necessary to change the acid several times before a thorough cleaning

could result. The second stage of the cleaning involved the transfer of the fossil bone fragments from the acid after thorough cleaning into a bath of running tap water so as to wash away the acid. The fossil bone fragments were left in the water bath for an equal length of time to that spent immersed in the acid. Finally, the fossil bone fragments were left to dry for several days and, as a measure of protection, the surfaces of the fossil bone fragments were coated with preservative (Bedocryl).

As a result of cleaning, the external appearance of the fossil bone fragments changed from blackish-grey to an ivory colour. The external surfaces became shiny and smooth to the touch and a wealth of anatomical details formerly concealed by the matrix, were revealed.

B. RECONSTRUCTION

The process of reconstruction was aimed at producing a reasonably anatomically reconstructed specimen by the use of the available fossil bone fragments. The procedure was a time-consuming exercise and required much patience. However, due to the excellent state of preservation of most of the individual bone fragments, the reconstruction was achieved with some confidence. Some of the fossil bone fragments lacked points of contact and had to be oriented to fulfil the anatomical requirements. In addition, some of the bones had undergone post-mortem plastic deformation.

For this reason, at certain points, the parts could not be made to fit together precisely. This applies especially to the temporal and frontal bones. The maxillofacial fragment posed a special problem during reconstruction as it is fragmentary and totally detached from the rest of the cranium and lacks direct points of contact.

The Laetoli Hominid 18 cranium, when recovered, was in many bony fragments that included some dental structures. The first task in the reconstruction of the cranium was to sort out and identify the available numerous fossil bone fragments and some teeth. There was a good reason to start with this exercise as it offered the best answer to a basic and puzzling question as to whether all the available fossil bone fragments belonged to only one or several individuals. During the sorting and identification process, special attention was paid to the general anatomical features of each fragment, the shape and the size, the type of the species, the side of the body to which the fragment belonged and the total number of the fossil fragments. After a long search, it was found to be almost certain that the fossil bone fragments belonged to only one individual. Most of these fragments were the ones used in the re-construction of Laetoli Hominid 18 cranium. Some of the fragments were either very minute or lacked clear anatomical features and could not be fitted to the reconstruction of the cranium. Several other fossil bone fragments belonged to other species and were identified as being of either avian, reptilian or of other mammalian origins.

Laetoli Hominid 18 cranium as it now stands, has been reconstructed from twenty-two (22) individual fossil bone fragments comprising of the frontal, parietal, occipital, temporal, orbital, maxillofacial and seven (7) teeth. The teeth consist of P^3, P^4, and M^1 on the right side and a stump of P^4 as well as M^1, M^2, and M^3 on the left side.

The reconstruction of the Laetoli Hominid 18 cranium was conducted in two stages; stage one involved the piecing together of the separate small fossil bone fragments and stage two involved the reconstruction of the whole cranium.

The type of adhesive material used to fix the various fragments together is known by the trade name (UHU). This adhesive material has the advantage of being acid-free, dries and holds fast and is resistant to water, petrol or oil. It is easily removed by dissolving it in acetone. The gaps were filled in with a commercial variety of modelling clay.

Stage I of the Reconstruction of Laetoli Hominid 18 Cranium

The assembly of the separate fossil bone fragments resulted in the formation of eight main parts of the cranium as follows: the frontal, the right parietal, the left parietal, the occipital, the right temporo-sphenoidal, the left temporo-sphenoidal, the orbital and the maxillofacial bones including the teeth.

The Frontal Bone (Plates 8-9): The frontal bone was restored from two separate fragments, one large and one small triangular fragment. The large fragment constitutes most of the frontal bone and retains well preserved contact points along its coronal margin with the parietal bones and, at its postero-lateral aspect on the left side, with the small fragment. In the reconstruction, the small fragment of the frontal bone, with its well preserved area of contact, was glued at the postero-lateral aspect of the large piece on the left side. The contact of the two fragments made a good interlocking fit to each other.

On the right side of the Laetoli Hominid 18 cranium, two frontal fossil bone fragments are preserved and form that part of the orbital roof. The two fragments both retain good areas of contact with each other and form a good fit when glued together. Anteriorly, the orbital fragments retain a good contact point with the rest of the frontal bone. Posteriorly, medially and laterally, the bone has irregular broken margins with no preserved direct articulation with either the lesser or the greater wings of the sphenoid bone.

With the above reconstruction, an almost complete frontal bone was achieved. The frontal bone consists of most of the anterior surface with an intact coronal margin, parts of the orbital region including the supraorbital notches, small portions of the nasal bones exposing two medium sized frontal air sinuses and parts of the zygomatic

processes of the frontal bone. The internal surface of the frontal bone is intact and almost complete. Although the frontal bone is almost complete, it suffered from some post-mortem plastic deformation that resulted in torsion to the right of the supraorbital region.

The Right Parietal Bone (Plates 10-11): The right parietal bone was reconstructed from three separate fragments. Two of the fragments are large and form most of the anterior and posterior parts of the right parietal, while the third fragment is small and forms a small portion of the inferolateral angle of the bone anteriorly. The fragment forming most of the anterior part of the right parietal bone, has a well preserved coronal margin for articulation with the frontal bone; part of the sagittal border for articulation with the parietal bone of the opposite side and a posterolateral margin for articulation with the fragment forming the posterior part of the right parietal bone. The fragment forming the posterior part of the right parietal bone, like the anterior fragment, has a well preserved part of the sagittal border and an anterior margin for both articulation with the parietal bone of the opposite side and the other anterior fragment respectively. The posterior fragment, unlike the anterior, has also well preserved lambdoid and temporal borders. The third small fragment retains a small area of contact with the posterior fragment and in addition, has a small bevelled lower border for articulation

with the squamous part of the right temporal bone.

In the reconstruction, the anterior and the posterior fragments were fitted together along their areas of contact while particular attention was paid to the alignment of the two fragments along the sagittal border. The small fragment was fitted and glued along its areas of contact to the posterior fragment. All of the three fragments fitted each other nicely to form an almost complete and intact right parietal bone. As such, the right parietal bone includes intact coronal, sagittal, lambdoid and temporal borders. Its cerebral surface is almost intact and presents a marked parietal fossa as well as impressions for the gyri of the right cerebral hemisphere together with vascular grooves for the branches of the right meningeal vessels.

The Left Parietal Bone (Plates 12-13)

The left parietal bone was restored from four separate fossil bone fragments consisting of two large and two small fragments. The two large fragments form much of the anterior and posterior parts of the left parietal bone while the other two small fragments form most of the sagittal and lower borders of the left parietal bone respectively. The anterior fragment, still retains its coronal border, together with parts of the sagittal border for articulation with the frontal and parietal bones respectively. In addition, the anterior fragment also retains a postero-inferior margin that makes good contact

with the posterior fragment and with the two smaller fragments. The posterior fragment of the left parietal bone, like the anterior fragment, also retains parts of the sagittal border and an antero-inferior margin for articulation with the parietal bone of the opposite side and with the anterior fragment of the left parietal bones respectively. The small fragment of the left parietal bone with part of the sagittal border has good contacts with both the anterior and the posterior fragments of the left parietal bone. The other small fragment of the left parietal bone also has good contact points with both anterior and posterior fragments of the left parietal bone.

Since all four fragments forming the left parietal bone had good contact points, the process of reconstruction was made easier. The left parietal bone like the right, consists of intact sagittal, coronal, and lambdoid borders. The cerebral surface is almost intact and presents a marked parietal fossa as well as impressions for the gyri of the left cerebral hemisphere together with the vascular grooves for the branches of the left meningeal vessels. Unlike the right parietal bone, the left parietal lacks most of its inferolateral part anteriorly and has a small triangular gap at its mid-parietal region. The small gap was filled in with plasticene during the reconstruction.

The Occipital Bone (Plates 14-15)

The occipital fragment was restored from one large piece constituting most of the squamous part. The basi-occiput and exoccipital portions are totally lacking. The squamous part of the occipital bone is virtually complete with intact lambdoid borders for the articulations with the two parietal bones. The bone only lacks a small portion of its postoccipital part that bounds the foramen magnum. No additional reconstruction was done to the occipital fragment.

The Right Temporo-Sphenoidal Fragment (Plates 16-18)

The right temporo-sphenoidal was restored from one large piece consisting of an almost complete and intact right temporal bone and parts of the sphenoid bone. The right temporal bone still retains its squamous, petrous and tympanic elements. The squamous part of the right temporal bone still retains almost intact superior and antero-inferior borders for direct articulation with the temporal border of the right parietal bone and with the posterior margin of the greater wing of the sphenoid bone respectively. The petrous part of the right temporal bone shows a considerable degree of surface wear. Its apex and all of its direct contact margins with the base of the cranium are totally missing. Only a small contact area of the tympanic part with the greater wing of the sphenoid bone is still retained at the base of the cranium. The mastoid part of the right temporal bone still retains a good contact area with the squamous part of the occipital

bone, posteriorly, and with the temporal border of the right parietal bone superiorly. The anterior part of the greater wing of the sphenoid bone is irregularly broken and lacks direct articulation with both the body and the lesser wing of the sphenoid bone. The zygomatic process is broken off.

The Left Temporo-Sphenoidal Fragment (Plates 19-21)

The left temporo-sphenoidal fragment was restored from two pieces of fossil bone and consists of an incomplete left temporal bone, together with parts of the sphenoid bone and a small separate piece of the squamous part of the temporal bone. The left temporal bone, unlike the right, lacks most of the squamous part, only a small portion of this bone is preserved. The small preserved piece of the squamous part of the left temporal bone retains a small bevelled upper margin for articulation with the temporal border of the left parietal bone. Its inferior margin, which can be articulated with the broken edge of the other remaining squamous bone, lacks a definite area of interlocking contact and can be moved from place to place. For this reason, this separate fragment of the squamous part of the left temporal bone was left out of this reconstruction. The tympanic part of the left temporal bone still has well preserved medial and anterior margins for articulation with the base of the cranium, the body, and the greater wing of the sphenoid bone. The mastoid part of the left temporal bone,

unlike that on the right side, lacks its postero-inferior margin for articulation with the squamous part of the occipital bone. Anteriorly, both the sphenoid and the squamous part of the temporal bone have irregular margins with no direct contact with the anterior part of the cranium.

The Maxillofacial Fragment and the Teeth (Plates 22-26)

The maxillofacial fragment was restored from seven separate fossil bone fragments and seven teeth. The process of reconstruction of the maxillofacial fragment was a difficult one as most of the fossil bones were fragmentary. However, the process was facilitated as most of these fragments had retained good contact points to each other. The reconstruction was done in two stages as follows: the first stage involved fitting and gluing together the various fragments that formed the separate right and left maxillae including their teeth. This was then followed by fitting together the separate left and right maxilla.

The right maxilla was restored from two fragments consisting of parts of the body of the maxilla, including parts of the right maxillary air sinus, parts of the palate and the alveolar process exposing several dental alveoli. The two fragments forming part of the right maxilla each retained good contact points to each other and the two fragments were articulated and glued together. The restored teeth in the right maxilla include P^3, P^4 and

M^1. All the teeth are badly worn and broken but still retain their roots. This made it possible to fit the three teeth in to their appropriate sockets.

The left maxilla unlike the right, was much more fragmentary and was restored from five fossil bone fragments including the teeth. The fragments include much of the body of the maxilla together with its anterior, infratemporal and nasal surfaces; the frontal process and much of the orbital surface; parts of the palate and the alveolar process exposing the dental root sockets. The fragments of the left maxilla have retained good areas of contact with each other and it was possible to fit and glue them together along these points. The preserved teeth in the left maxilla include the stump of P^4, including M^1, M^2, and M^3. All of the teeth like those in the right maxilla are badly worn but retain their roots.

The teeth fitted in the left maxillary alveolar process include, M^1, M^2, and M^3. The stump of P^4 was intact in its alveolar socket.

The final stage of the reconstruction of the maxillofacial fragment involved the articulation of the two maxillae. This part of the reconstruction was difficult but was made possible due to the fact that the two maxillae had clear points of contact in the midline. The two maxillae were placed on a flat surface and the maxillae were then articulated in the midline and orientated in such a way as to form a gentle and continuous nasal

curvature. Meanwhile, the reconstruction was further guided by the position and the plane of the palate, the course of the alveolar margin, the shape of the dental arcade, together with the position of the occlusal surfaces of the teeth and the position of the median nasal crest including that of the nasal spine.

Reconstruction of the Whole Cranium

The task of reconstruction of the whole cranium of Laetoli Hominid 18 involved assembling and gluing together of the eight major parts that resulted from the previous reconstruction. These major parts of the cranium consist of the frontal, the right and left parietal, the occipital, the right and left temporo-sphenoids, and the maxillofacial including the teeth.

The first stage of the reconstruction of the whole cranium began by the fitting and gluing together of the two well preserved parietal bones along their sagittal borders. Both of the parietal bones have well preserved sutures along their sagittal, coronal and lambdoid borders. During this reconstruction, the two sagittal borders of the two parietal bones were first coated by glue and were brought together. While the points of contacts were still soft, the two parietal bones were articulated and orientated in such a way that a good interlocking fit was formed both externally and internally. The fragments were then held firmly in the hands. Particular attention was paid in obtaining an even alignment of the two parietals along

their coronal and lambdoid borders and to the general contour of the two bones as viewed from different angles particularly from the top and the cerebral surfaces. The two parietals were then placed on a soft surface and supported. Some rubber bands were also applied to keep the fragments together. The glued points of contacts of the two parietals were then left to dry and become firm before proceeding to the next stage of the reconstruction. The small gaps between the bones were filled in with modelling clay.

The next stage of the reconstruction involved in fitting the frontal fragment to the biparietal arch. This reconstruction was made easier by the excellent preservation of the coronal borders on both the frontal and the biparietal fragments. The coronal borders were coated with glue and then fitted together. Similar to the previous reconstruction, the frontal and the biparietal fragments were articulated in a way that resulted in a good interlocking fit both externally and internally. As in the previous reconstruction, the frontal and the biparietal fragments were first held in the hands and later were placed on a soft surface and supported and left to dry and become firm. The smaller gaps were filled with modelling clay. This stage of the reconstruction, completed the formation of the anterior and middle parts of the cranial vault.

The posterior aspect of the cranium was completed by fitting on the occipital fragment to the biparietal

arch along the lambdoid border. Both the occipital and the biparietal arch had retained good contact points along the lambdoid borders. The part of the cranium formed so far was placed on a soft surface with its cerebral surface facing upwards. Glue was then applied to both fragments along their lambdoid borders and the two margins were fitted together. The bones were first firmly held together in the hands and were moved so that a good fit was obtained. Both the external and cerebral surfaces were inspected for even alignment. Lastly, the fragments were left to dry. The gaps between the contact points were filled with modelling clay.

The sides and the base of the cranium were completed by the fitting of the two temporosphenoid fragments. This latter reconstruction was difficult as parts of the temporosphenoid fragment and most of the base of the cranium are missing. The right temporosphenoid fragment was relatively easy to fit since it still retains most of its contact points along the superior and inferolateral margins of the squamous part of the right temporal bone. The left temporosphenoid fragment, unlike the right one, is incomplete and suffered from post-mortem plastic deformation. The fragment has lost most of its contact points with both the parietal and the occipital fragments. In this part of the reconstruction, the main cranial fragment formed during the previous reconstruction was placed on a flat surface with its cerebral surface facing upwards. Some glue was placed first on the lower border of

the right parietal bone and to the lambdoid border of the occipital fragment. This was followed by the application of glue to the superior and posterior borders of the squamous part of the right temporal bone. The right temporosphenoid fragment was then fitted to the parietal and occipital bones along their lines of contact. In this reconstruction, particular attention was paid to the Frankfurt plane, the level of the base of the cranium and to the internal alignment of the fragment as revealed by the course of the branches of the internal meningeal vessels as they crossed the suture lines. The fitting of the right temporosphenoid fragment was used as a basis for fitting the incomplete left temporosphenoid fragment. The left temporosphenoid fragment has only a small contact point along its superior border with the squamous part of the left temporal bone. This limited surface area, and the corresponding area along the inferior margin of the left parietal bone were glued together. While the contacts were still soft, the left temporosphenoid fragment was orientated to give a good interlocking fit. Due to its incompleteness, and to the fact that this fragment had undergone some plastic deformation, there was no direct contact of this fragment with the occipital fragment along the lambdoid border. This has resulted in some springing of this suture.

The final stage of the reconstruction of the whole cranium of Laetoli Hominid 18, was an attempt to position the maxillofacial fragment with the rest of the

cranium. This was difficult because the maxillofacial fragment is totally detached from the rest of the cranium and does not have any direct contact points. The frontal fragment also posed another problem since it is twisted to the left side as a result of post-mortem plastic deformation. It was thus difficult to assess with certainty the exact midline of the cranium as a whole. However, there were some useful points preserved on both the frontal and the maxillofacial fragments. The frontal bone still retains the nasion and parts of the nasal bones, and on the left side, most of the frontal process of the maxilla is preserved and has broken off only a few millimetres from the nasion.

During the attempted positioning of the face and the main part of the cranium the vault and the maxillofacial fragments were firmly held by folded clamps so that their relative positions could be adjusted in the three spatial planes. By means of trial and error combined with the use of cranial bilateral symmetry, the face was positioned with respect to the vault. This aspect of the reconstruction must be considered speculative. The position was recorded photographically (Plates 2-4).

C. OSTEOMETRY

Cranial measurements are traditionally widely reported data in palaeoanthropology (Corruccini, 1974). In the past, the study of comparative craniometry has greatly been hindered due to the lack of fundamental definitions and techniques of measurements amongst the earlier workers. However, since the Frankfurt agreement (1882), the trend has gradually been reversed and more standardized techniques are now being utilised.

Among the distinguished workers in the subject of comparative craniometry include: Karl Pearson (1887), Martin (1914-1928), Morant (1928), Trevor (1950), Vallois (1965), Brothwell (1965), Tobias (1967), Howells (1970 and 1973), Bilsborough (1971) and Stringer (1974).

In the present study, in an attempt to be consistent with the previous workers, the system of cranial measurements chosen was that formulated by Howells (1973) and subsequently used by other investigators (Stringer, 1974).

The maximum number of available measurements were taken on the Laetoli Hominid 18 cranium and from the preserved teeth (Tables 4-6). Similar measurements were taken from all the comparative fossil and modern crania and are shown in Tables 7-9. All of the measurements were entered in a specially prepared data collection sheet (Table 2). Measurements were only recorded where they could be accurately ascertained. On occasion, where definitive landmarks on the cranium were less certain as

the result of breakage or erosion of parts, measurements were estimated to very close limits. Measurements from reconstructed specimens like the Florisbad cranium were taken with caution. All the measurements were recorded in millimetres to the nearest one tenth of a millimetre.

The instruments used during this study included the standard spreading calipers with relatively pointed ends, large and small dial sliding calipers, the standard form of co-ordinate calipers (Radiometer) and a non-elastic measuring tape.

The definitions of the cranial landmarks, together with the techniques of measurements are described below and are based on Howells (1973). It was not easy to locate and define with satisfaction any new cranial landmarks and measurements on the Laetoli Hominid 18 cranium but two new additional measurements were added to Howells (1973) list. The added measurements are the bregma/asterion arc and chord.

(a) <u>The Cranial Landmarks on the Laetoli Hominid 18 Cranium (Definitions based on Howells (1973)</u>.

(i) Asterion: The point at which the sutures between the temporal, the parietal and the occipital bones meet. The asterion is well preserved and easily located on both sides of the Laetoli Hominid 18 cranium.

(ii) Bregma: The point at which the coronal and sagittal sutures meet. The bregma is also well preserved and easily located on the Laetoli Hominid 18 cranium.

(iii) Dacryon: The point at which the sutures between the frontal maxillary and the lacrimal bones meet. This point is not easily located on both sides of the Laetoli Hominid 18 cranium. Its position was located by estimation.

(iv) Lambda: The point at which the sagittal and lambdoid sutures meet. The lambda is well preserved and easily located on the Laetoli Hominid 18 cranium.

(v) Nasion: The midpoint of the suture between the frontal and the two nasal bones. This point is easily located on the Laetoli Hominid 18 cranium.

(vi) Glabella: The most anterior point in the median sagittal plane of the bony prominence joining the superciliary ridges. This point though slightly distorted due to some torsion of the anterior part of the frontal bone, is easily located in the Laetoli Hominid 18 cranium.

(vii) Opisthocranium: A point on the posterior aspect of the cranium furthest from the glabella in the median sagittal plane of the cranium. The point is easily located on the Laetoli Hominid 18 cranium.

(b) The Cranial Measurements of the Laetoli Hominid 18 (Definitions and Technique after Howells, 1973)

(i) Nasion-Bregma Arc (Frontal Arc): Direct distance from the nasion to the bregma, taken in the midline over the external surface of the frontal bone. As both the nasion and the bregma are easily located on the Laetoli Hominid 18 cranium, it was easy to take the measurement. The cranium was made to rest on its right asterion so as to get a good view of the frontal region and by means of a non-elastic tape, the measurement was taken. The accuracy of the technique was re-checked by repeating the measurement when the cranium was laid on its left asterion.

(ii) Bregma-Lambda Arc (Parietal Arc): Direct distance from the bregma to the lambda, taken in the sagittal plane over the external surface of the parietal bone. This measurement, like that of the nasion-bregma arc, was easily taken as both the bregma and the lambda are easily located. The same technique as that for the nasion-bregma arc was applied.

(iii) Bregma-Asterion Arc: Direct distance from the bregma to the asterion, taken over the external surface of the parietal bone. The cranium was laid on its right asterion so as to have a good view of the left parietal bone including the bregma and asterion points. The measurement was taken by means of a non-elastic tape

measure. The procedure was repeated on the opposite side of the cranium and the mean of the two readings was recorded.

(iv) Glabello-Occipital Length: Greatest length from the glabellar region in the median sagittal plane. The cranium was rested with its base facing the observer so as to have a clear outline of the midline. And by the use of a standard spreading calipers with relatively pointed ends the measurement was taken. First, one end of the left caliper was placed at the glabellar region in the midline, while the right caliper was moved along the occiput in the midline for a maximum reading. This reading was re-checked by moving up and down of the left caliper. The procedure was a difficult one as the profile of the occipital region is not even and thus it was necessary to take several readings before coming to a constant value.

(v) Nasion-Occipital Length: Greatest cranial length in the median sagittal plane, measured from nasion. The cranium was placed in the same position as that for the glabello-occipital length. The left caliper point was placed at the nasion while the right point was moved along the occiput in the midline for the maximum reading. Like the glabello-occipital length, several attempts were made before determining the exact measurement.

(vi) Maximum Cranial Breadth: The maximum cranial breadth perpendicular to the median sagittal plane (above the supermastoid crests). The cranium was rested on its base, with the occiput facing the observer. The points of the spreading calipers were placed first in the region of the parietals and later on the temporals. For the Laetoli Hominid 18 cranium, the maximum cranial breadth was found at the regions of the parietal bones. As a whole, this measurement needed great care as it involved the symmetrical positioning of the calipers.

(vii) Maximum Frontal Breadth: The maximum breadth at the coronal suture, perpendicular to the median plane. The cranium was rested on its base with its face facing the observer. The two points of the spreading calipers were placed at the coronal suture on either side and the maximum reading was found. The procedure like that for the maximum cranial breadth required great care and several readings were taken before determination of the exact reading.

(viii) Nasion-Bregma Chord (Frontal Chord): The frontal chord, or direct distance from nasion to bregma, taken in the midplane and at the external surface. The cranium was rested on its right asterion so as to have a good left profile view of the frontal region. The two points of the coordinate caliper were placed at the bregma and nasion and were kept in position by means

of screws. Great care was taken of not letting the points sink into the sutural clefts. The reading was re-checked by resting the cranium on its left side.

(ix) Nasion-Bregma Subtense (Frontal Subtense): The maximum subtense, at the highest point on the convexity of the frontal bone in the midline, to the nasion-bregma chord. This measurement was taken while the co-ordinate caliper was still in position for the nasion-bregma chord. The co-ordinate point of the caliper was moved back and forth several times in the sagittal plane to find a tangent to the curve of the frontal bone at its highest point and then the caliper arm was kept at this point by means of a screw.

(x) Nasion-subtense Fraction: The distance along the nasion-bregma chord recorded from nasion, at which the nasion-bregma, or frontal, subtense falls. This reading was taken directly from the cranium when the caliper was still in position for the nasion-bregma chord and nasion-bregma subtense positions.

(xi) Bregma-lambda Chord (Parietal Chord): The external chord, or direct distance from bregma to lambda, taken in the midplane and at the external surface. The same technique as for the nasion-bregma chord was repeated.

(xii) Bregma-lambda Subtense (Parietal Subtense): The maximum subtense, at the highest point on the convexity of the parietal bones in the midline midplane, to the bregma-lambda chord. The same procedure as for the nasion-bregma subtense, with the caliper in position for bregma-lambda chord. Care was taken not to let the points of the calipers sink into the sutural clefts.

(xiii) Bregma-Subtense Fraction: The distance along the bregma-lambda chord, recorded from bregma, at which the bregma-lambda, or parietal, subtense falls. The same technique as for the nasion-sub-tense fraction.

(xiv) Bifrontal Breadth: The breadth across the frontal bone between frontomalare anterior on each side, i.e. the most anterior point on the frontomalar suture. The frontomalare anterior points are slightly broken off, but a sufficient area of bone is still preserved to allow the measurement to be taken. Thus, each arm of the coordinate caliper was placed at the approximated frontomalare anterior on each side of the frontal bone and firmly secured by means of screws. During this procedure, the cranium was set to rest on its vertex.

(xv) The Nasion-Frontal Subtense: The subtense from nasion to the bifrontal breadth. This measurement was taken while the coordinate caliper was still in position for the bifrontal breadth position. Particular care was

taken not to let the points of the caliper sink into the sutural edges.

(xvi) Glabella Projection: The maximum projection of the midline profile between nasion and supraglabellare (or the point at which the convex profile of the frontal bone changes to join the prominence of the glabellar region), measured as a subtense. The cranium was set to rest on its right occiput and its left side to the observer. One arm of the coordinate caliper was set at the nasion and the second arm was set on the frontal bone at the lowest point above any part of the glabellar eminence. The coordinate arm was then moved to and fro for the most prominent point in the midline profile. This procedure was repeated several times in order to obtain a constant reading.

(xvii) Supraorbital Projection: The maximum projection of the left supraorbital arch between the midline, in the region of the glabella or above, and the frontal bone just anterior to the temporal line in its forward part, measured as a subtense to the line defined. Both sides of the Laetoli Hominid 18 were measured for the supraorbital projections and their mean recorded. The cranium was first rested on its right side of the occiput while the frontal region faced the observer. The fixed arm of the coordinate caliper was placed on the frontal surface next to the incurvature of the temporal line.

The movable point of the caliper was placed in the midline near the glabella and by lowering the coordinate arm, the highest reading was found. The procedure was difficult to perform as there are no clearly marked or fixed points for the measurement.

(xviii) Inter-orbital Breadth: The breadth across the nasal space from dacryon to dacryon. This measurement was estimated on the Laetoli Hominid 18 as the dacryon point is not well indicated on both sides of the cranium. The measurement was taken with the cranium lying on its vertex and the lateral points of the caliper were placed at the dacryon. Attention was particularly paid to the estimated positions of the dacryon on both sides of the cranium.

(xviv) Minimum Cranial Breadth: The breadth across the sphenoid at the base of the temporal fossa, at the infratemporal crests. This measurement was estimated as only small portions of the sphenoid and temporal fossa are preserved in the Laetoli Hominid 18 cranium. The measurement was taken with the cranium resting on its vertex and the occiput facing the observer.

(xx) Bistephanic breadth: Breadth between the intersections, on either side, of the coronal suture and the inferior temporal line marking the origin of the

temporal muscle (the stephanion) points. The measurement was taken at the intersections, on either side of the coronal suture and temporal crest. The cranium was rested as for the maximum frontal breadth measurement.

(xxi) Bregma/asterion Chord: Direct distance from the bregma to the asterion, taken over the surface of the parietal bone. The cranium was rested as for the bregma asterion arc measurement and the two points of the coordinate caliper were placed at the bregma and asterion. Care was taken not to let the points of the caliper sink into the sutural clefts. The reading was re-checked by resting the cranium on its left side and the average of the two readings was recorded.

(xxii) Biasterionic Breadth: Direct measurement from one asterion to the other. The cranium was rested on its frontal region, the occiput facing the observer. The distance from one asterion to the other was measured by the use of sharp pointed dial sliding caliper.

(xxiii) Biauricular Breadth: The least exterior breadth across the roots of the zygomatic processes, wherever found. The cranium was rested on its occiput and the base towards the observer. The measurement was taken to the outside of the roots of the zygomatic process at their deepest incurvature.

(xxiv) Mastoid Height: The length of the mastoid process below, and perpendicular to, the Frankfurt plane, in the vertical plane. Both mastoid processes were measured in the Laetoli Hominid 18 cranium and the average of the two measurements was recorded. The cranium was rested first on its right side and face facing the observer. The calibrated bar of the sliding caliper (dial) was placed just behind the process on the left side, so that the fixed arm was tangentially to the upper border of the auditory meatus and pointing to the lowest point on the border of the orbit. The measuring arm was then moved until it was level with the tip of the process.

(xxv) Mastoid Width: Width of the mastoid process at its base, through its transverse axis. The measurement was taken from the point of the digastric groove and both mastoids were measured, the average of the two reading was recorded.

(xxvi) Palate Breadth, External: The greatest breadth across the alveolar borders, wherever found, perpendicular to the median plane. The cranium was rested with its base facing upwards and the flat arms of the sliding caliper (dial) were applied to the bone of the alveolar border to find the maximum reading. The arms of the calipers were kept parallel during this procedure.

(xxvii) Vertex Radius: The perpendicular to the transverse transmeatal axis from the most distant point on the parietals (including bregma or lambda), wherever found. The cranium was rested on its lower occiput, the face to the observer. The plugs of the radiometer were plugged gently and simultaneously into the meatus on either side until they were firm. The coordinate arm of the radiometer was then moved back and forth sagittally, to find the maximum reading. In the Laetoli Hominid 18 cranium, this reading coincided with the bregma.

D. STATISTICAL ANALYSES

Three methods of statistical analyses were used in this study and included:

(a) Univariate analysis

(b) Bivariate analysis

(c) Multivariate analysis.

The first two of the analyses are discussed under the section of the results. These were chosen since they are simple to use and the significance of their results are easier to interpret than those of the more complex multivariate statistical methods.

(c) Multivariate Analysis

(i) Canonical Variate Analysis

The canonical variate analysis was chosen in this study as it permits the use of large samples of groups to be compared and, indirectly, can be applied to individual or fragmentary fossils. The technique has the advantage of comparing the total morphological patterns of groups simultaneously rather than the use of univariate analysis, moreover, the technique best distinguishes between groups in a multi-dimensional space and informs the individual of the variables contributing most to the separation. In this study, the canonical variate analysis was employed as an aid in verifying the position of the Laetoli Hominid 18 cranium in relation to both hominid fossils and modern crania.

The technique has been recognised for a long time and has been used in various fields of research. It was revised by Hotelling in 1936 and is related to discriminant function analysis devised by Fisher in 1936. Simplified explanations of the technique have since been written by Maxwell (1961), Healy (1965) and Bartlett (1965). Of the previous workers who have used the canonical variate analysis technique are included, Mahalanobis et al., (1949), Rao (1952), Ashton et al., (1957), Ashton et al., (1965), Day (1967), Day and Wood (1968), Musgrave (1970), Bilsborough (1971) and Stringer (1974) and more recently, Rightmire (1979).

(ii) Mahalanobis' D^2 or Generalised Distance

This technique revised by Mahalanobis in 1936, was also employed in this study. The technique has the advantage of including all variables by taking account of the correlation between them, while rejecting the redundant information. Detailed description of the technique has been written by Trevor (1947) and Mahalanobis et al., (1947).

(iii) Description of Program

The program used was that of the Gerstat package. It is a general statistical program, 4.01 formulated by Rothamsted Experimental Station in 1977 and is currently used at the University of London Computing Centre.
The processing of the data involved three main steps as follows:

Step 1: Data scaling; for each variable; subtract mean from data and divide by standard deviation.

Step 2: Replacing missing values by group mean.

Step 3: Canonical variate analysis.

(iv) Layout of data

The numerical data on each hominid fossil and modern cranium was punched on 80 column cards and the results were printed out up to four decimal places.

TABLE 2. Sample of the Data Collection Sheet used during the research.

Name: Address:

Date:

Title of Investigation:

1. Serial number:

2. Brief description of specimen:

3. Genus 1. Homo

4. Species 1. Erectus
2. Early
3. Early modern
4. Sapiens

5. Sub-species

1. European
2. Middle East
3. Far East/Australia
4. Sub-Saharan
5. North African
6. Chinese
7. Sapiens

6. Parts 1. Frontal
2. Parietal
3. Occipital
4. Frontal/Parietal
5. Parietal/Occipital
6. Frontal/Parietal/Occipital
7. Vault
8. Cranium
9. Whole skull
10. Face
11. Teeth

7. Sex 1. Male
2. Female
3. Unknown

... Cont'd...

8. Place of Storage:

1. B.M.(N.H.)
2. St. Thomas'
3. National Museum of Tanzania
4. Cambridge University
5. Others

9. Museum Number:

10. Cranial Vault Shape
1. Oval
2. Round
3. Oval/Low/Long
4. Oval/Low/Short
5. Oval/High/Short
6. Receding/Flattened
7. Receding/Flattened/Keeling
8. Receding/Keeling
9. Vertical/Round/Bossing
10. Vertical/Flattened

11. Forehead Shape:
1. Receding
2. Vertical
3. Keeling
4. Flattened
5. Vertical/Round
6. Receding/Flattened
7. Receding/Flattened/Keeling
8. Receding/Keeling
9. Vertical/Round/Bossing
10. Vertical/Flattened

12. Temporal lines
1. Prominent
2. Faint
3. High
4. Low
5. Prominent/High
6. Faint/Low

13. Parietals
1. Flattened
2. Keeling
3. Bossing/Flattened
4. Round
5. Round/Bossing
6. Flattened/Keeling/Bossing
7. Flattened/Keeling
8. Round/keeling

... Cont'd...

14. Occipital
    1. Round
    2. Flattened
    3. Angulated
    4. Angulated with torus
    5. Round with torus
    6. Flattened with torus
    7. Flattened/Angulated/torus

15. Supraorbital Torus
    1. Cunningham type I
    2. Cunningham type II
    3. Cunningham type III

16. Mastoid Process
    1. Small
    2. Large

LIST OF MEASUREMENTS: (ALL MEASUREMENTS IN M/M

1. Nasion Bregma Arc (Frontal Arc) FRA

2. Bregma Lambda Arc (Parietal Arc) PAA

3. Bregma Asterion Arc Left Side (BAA)

Right Side

4. Glabello-Occipital Length GOL

5. Nasio-Occipital Length NOL

6. Maximum Cranial Breadth XCR

7. Maximum Frontal breadth XFB

8. Nasion-Bregma Chord (Frontal Chord) FRC

9. Nasion-Bregma Subtense (Frontal Subtense) FRS

10. Nasion-Sbutense Fraction FRC

11. Bregma Lambda Chord (Parietal Chord)PAC

12. Bregma Lambda Subtense (Parietal Subtense) PAS

13. Bregma Subtense Fraction PAF

14. Bifrontal Breadth FMB

15. Nasio Frontal Subtense NAS

16. Glabella Projection (Central) (GLS)

17. Supraorbital Projection Left Side (SOS)

Right Side

Average

18. Interorbital Breadth DKB

19. Minimum Cranial Breadth MFB

20. Bistephanic Breadth (STB)

21. Bregma Asterionic Chord - Left Side (BAC)

Right Side

Average

22. Biasterion Breadth ASB

23. Biauricular Breadth AUB

24. Mastoid Height MDH Left side

Right side

Average

25. Mastoid width (MDB) Left Side

Right Side

Average

26. Palate Breadth (External) MAB

27. Vertex Radius (VRR)

V. RESULTS

1. ANATOMICAL COMPARISONS OF THE LAETOLI HOMINID 18 CRANIUM WITH OTHER FOSSIL HOMINID AND MODERN CRANIA

As previously stated, the Laetoli Hominid 18 cranium is almost complete and includes the bones of the vault, much of the base, both temporal bones, part of the sphenoid and much of the face including the palate and part of the upper dentition. As recovered, the cranium was in 22 pieces, all heavily mineralised with no signs of pathology, but there are signs of post-mortem plastic deformation that has resulted in torsion to the right of the supraorbital region and some springing of the temporo-occipital suture on the left. It was possible to re-assemble the vault and the base into one structure and the paired maxillae into another. Unfortunately there is no point of contact between the facial skeleton and the calvaria although very little bone is missing. The relationship between these two main fragments of the cranium remains speculative.

Using this reconstruction, the position of the Laetoli Hominid 18 cranium with respect to other hominid fossil hominids and modern crania from Africa, the Middle East, Far East/Australia, and Europe may now be examined. The comparative specimens comprised of 31 fossil hominid crania of which six were originals including the Kabwe, Singa, Kanjera, Tabūn I, Wadjak I and Swanscombe. The remainder of the fossil hominid crania were casts. These

comparisons were mainly confined to the general form of the cranium, the profiles of the frontal, parietal, occipital and temporal bones; the cranial base, the maxillofacial fragment and the endocranial cast, as these are clearly demonstrated in the Laetoli Hominid 18 cranium.

A. THE GENERAL FORM OF THE LAETOLI HOMINID 18 CRANIUM COMPARED WITH OTHER FOSSIL HOMINID CRANIA

In general form, the Laetoli Hominid 18 cranium is large, ovoid, low vaulted and with relatively thickened cranial bones. The above features of the Laetoli Hominid 18 cranium seem to separate it significantly from anatomically modern *Homo sapiens* crania, but places the Laetoli cranium closer to the more archaic *Homo sapiens* crania.

Viewed from the front, the Laetoli Hominid 18 cranium shows several striking features including the developed and divided brow ridges, the lowness of the cranial vault, the slightly keeled frontal bone in the sagittal plane and the prominence of the mid-parietal bossing. Thus, viewed from the front, the Laetoli Hominid 18 cranium shows more of the archaic features than those that are more advanced. The cranium shows some resemblance to anatomically modern crania in the development of the mid-parietal bossing but differs greatly from the latter in the degree of development of the brow ridges, the keeled frontal and in the lowness of the cranial vault.

From the frontal view, the Laetoli Hominid 18 cranium shows some similarities to a number of early African *Homo sapiens* crania including the Eyasi I, Omo I, Omo 2, Kabwe, Saldanha, Florisbad, Iwo Eleru and Djebel Irhoud.

The Eyasi I, like the Laetoli Hominid 18 cranium when viewed from the front, presents with an almost similar lowness of the cranial vault, development of the brow ridges and the prominence of the mid-parietal bossing. However, the Eyasi I, unlike the Laetoli Hominid 18 cranium presents with neither an ophryonic groove nor keeled frontal region.

Apart from the higher cranial vault and the absence of a keeled frontal profile, the Omo I cranium almost presents with a similar profile to the Laetoli Hominid 18 cranium when viewed from the front. Thus, the Omo I, like the Laetoli Hominid 18 cranium presents with an almost similar development of the brow ridge and glabella. In addition, the Omo I cranium, like the Laetoli Hominid 18 cranium, also presents with a shallow ophryonic groove, together with pronounced mid-parietal bossing.

The Omo 2 cranium, unlike the Omo I, shows fewer similarities to the Laetoli cranium when viewed from the front. Thus, the Omo 2 cranium like the Laetoli Hominid 18 cranium presents with a low flattened and keeled frontal profile but the degree of the frontal lowness and flattening in the Omo 2 cranium is more marked

than in the Laetoli Hominid 18 cranium. The greatest difference between the Omo 2 cranium and the Laetoli Hominid 18 cranium, when viewed from the front, lies in the development of the supra-orbital region and the posterior profile of the parietal region. Thus, the Omo 2 cranium unlike the Laetoli Hominid 18 cranium presents with a massively developed supra-orbital torus forming almost a continuous bar across the orbits. The anterior view of the Omo 2 cranium is comparable to that of the Kabwe, Saldanha and possibly to the Florisbad cranium. The frontal similarity of the Omo 2, Kabwe, Saldanha and Florisbad skulls has also been expressed by Rightmire (1978). The Kabwe, Saldanha and the Florisbad crania, unlike the Laetoli Hominid 18 cranium when viewed from the front, thus present with massively developed supra-orbital tori. The Djebel Irhoud cranium like the Kabwe cranium, differs from the Laetoli Hominid 18 cranium in the development of the supra-orbital torus whereas the Singa cranium unlike the Laetoli Hominid 18, presents with marked narrow frontal profile together with much more pronounced parietal bossing.

The other early African *Homo sapiens* crania such as the Matjes River and the Fish Hoek crania, unlike the Laetoli Hominid 18 cranium present with higher cranial vaults and with moderately developed brow ridges and glabella.

The O.H. 9 cranium, however, when viewed from the front, unlike the Laetoli Hominid 18 cranium, presents

with a markedly low, flattened cranial vault and with a massively developed supra-orbital torus and glabella. The frontal view profile of the O.H. 9 is comparable to that of the Pekin *Homo erectus* crania.

The Middle East early *Homo sapiens* such as the Tabūn I, Amud I and Skhūl 5, unlike the Laetoli Hominid 18 cranium, present with much higher vaults, laterally expanded parietals and with massively developed supra-orbital torus together with the glabella. The frontal view of the Middle East early *Homo sapiens* crania mentioned above show some similarities to some of the European classic Neanderthaler crania such as those of La Chapelle-aux-Saints and the La Ferrassie.

The Far East/Australia crania such as the Wadjak I and Keilor I, when viewed from the front, differ from the Laetoli Hominid 18 cranium in the development of the brow ridges and the height of the cranial vault. Thus, the above Far East/Australia crania, unlike the Laetoli Hominid 18 cranium, present with moderately developed brow ridges and with much higher cranial vaults.

The frontal view of the Laetoli Hominid 18 cranium in the light of other fossil and modern crania clearly places the cranium closer to some of the early African *Homo sapiens* crania such as the Eyasi I, Omo I and Iwo Eleru. The Laetoli Hominid 18 cranium thus shows some differences from the Kabwe, Saldanha, Omo 2, Florisbad and the Djebel Irhoud crania. Other African

early fossil crania such as the Matjes River and the Fish Hoek also show some differences from the Laetoli Hominid 18 cranium. Similarly, the frontal profile also differentiates significantly between the Laetoli Hominid 18 cranium and those of the Middle East, Europe, the Far East/Australia and the Pekin fossil hominid crania.

In lateral view, the Laetoli Hominid 18 cranium further shows striking features including the recession of the frontal region, the presence of a shallow ophryonic groove on either side of the midline, a developed occipitomastoid crest, small mastoid processes, a narrow tympanic passage together with a thickened tympanic plate and a rounded occipital profile. In lateral view, the Laetoli Hominid 18 again shows some similarities to a number of early African fossil hominids including the Eyasi I, Omo I and Iwo Eleru. In addition, the cranium shows some similarities, in certain features, to the Singa, Kabwe, Saldanha, O.H. 9, Djebel Irhoud, Tabūn I, La Chapelle-aux-Saints, Swanscombe and Gibraltar crania.

The Eyasi I calvarium when viewed from the side resembles the Laetoli cranium in a number of characters including the recession of the frontal region, the rounded profile of the occipital region together with the degree of development of the occipital torus and the smallness of the mastoid processes. The two crania only differ in the absence of an ophryonic groove in the Eyasi crania. The Omo I cranium, though with higher cranial vault than

the Laetoli Hominid 18 cranium, presents with similar parietal and occipital profiles. The Iwo Eleru cranium, like the Laetoli Hominid 18 cranium presents with an almost similar recession of the frontal region, roundness of the occipital region and smallness of the mastoid processes. The Kabwe, Omo 2, Saldanha and Djebel Irhoud skulls when viewed from the side, diverge greatly from the Laetoli Hominid 18 cranium. Thus, the Kabwe cranium presents with an angulated occipital profile, massive mastoid processes and with well marked supramastoid crests. The Omo 2 cranium presents with almost similar features to the Kabwe cranium but resembles the Laetoli Hominid 18 cranium in having developed occipitomastoid crests. The small size of the mastoid processes in the Laetoli Hominid 18 is a feature also present in the O.H. 9, Matjes River, Singa, Fish Hoek, Djebel Irhoud, Tabūn I, La Chapelle-aux-Saints and the Gibraltar crania. In addition, the La Chappelle-aux-Saints and the La Ferrassie, like the Laetoli Hominid 18 present with developed occipitomastoid crests together with centrally limited occipital tori. The Swanscombe remains, like the Laetoli cranium presents with a rounded occipital and parietal profiles when viewed from the side.

The posterior view of the Laetoli Hominid 18 cranium further confirms the rounded profile of the occiput, and the moderately under-cut occipital torus limited in the central part of the occiput. The maximum width of the cranium is higher up at the parietal region. In the

posterior view, the Laetoli Hominid 18 cranium shows resemblance to the Eyasi I, Omo I and Iwo Eleru. Other early African fossil hominids like the Kabwe, Saldanha and the Omo 2 skulls diverge from the Laetoli cranium in having a sloping profile of the occipital region accompanied by an angulated and well developed occipital torus extending towards the mastoid regions. The European Neanderthals like the La Chapelle-aux-Saints and the La Ferrassie skulls, unlike the Laetoli Hominid 18 cranium, present with bun-shaped occipital profiles together with well developed but centrally limited occipital tori.

From the basal view, the Laetoli Hominid 18 cranium reveals small sized frontal air sinuses and deep widened glenoid fossae. It is unfortunate that most of the comparative hominid fossil crania lack the basilar part, however the degree of development of the frontal air sinuses and the size of the mandibular fossae varied greatly in the few specimens observed. In the Kabwe cranium for example, the frontal air sinuses are very large and deep compared to those of the Laetoli Hominid 18 cranium in which the sinuses are small and not deep. The Saldanha cranium and the Kabwe cranium show much larger frontal air sinuses compared to the Laetoli cranium whereas in the Singa cranium the sinuses are also moderately developed as in the Laetoli Hominid 18 cranium. The mandibular fossae in the Omo 2 calvarium as in the Solo I and La Ferrassie examples are deep and large while in the Pekin *Homo erectus* crania these structures are deep but narrow.

B. THE FRONTAL BONE MORPHOLOGY OF THE LAETOLI HOMINID 18 CRANIUM COMPARED WITH OTHER HOMONID FOSSILS AND MODERN CRANIA

The frontal bone morphology of the Laetoli Hominid 18 cranium is flattened, receding, slightly keeled and with a shallow ophryonic groove. The bone is expanded posteriorly with no marked post-orbital constriction. In the frontal bone morphology, the Laetoli Hominid 18 cranium shows some similarities to a number of early African hominids including the Eyasi I, Kabwe, Omo I, Omo 2, Saldanha, Florisbad and the Iwo Eleru crania. The frontal portion of the Eyasi I shows similarities to that of Laetoli Hominid 18 cranium in the degree of flatness, recession and the development of the supra-orbital torus and the glabella. However, the frontal bone of the Eyasi I, unlike that of the Laetoli Hominid 18 cranium presents with neither ophryonic groove nor keeling. The Kabwe frontal on the other hand, unlike that of the Eyasi I shows only some minor resemblances to that of the Laetoli Hominid 18 cranium. Thus, the Kabwe frontal bone resembles that of the Laetoli Hominid 18 cranium in the degree of its recession and flatness. The bone is quite different in the two crania in several respects. The frontal bone of the Kabwe skull, unlike that of the Laetoli Hominid 18, is narrow, unkeeled and with no ophryonic groove. In addition, the supra-orbital torus, together with the glabella, are more massively developed in the Kabwe frontal than in the Laetoli Hominid 18 cranium. Another main feature of the Kabwe frontal, unlike that of the Laetoli Hominid 18 cranium,

is the marked outcurving of the anterior temporal lines joining the lateral ends of the supra-orbital structures and the presence of deep temporal fossae.

The Omo I frontal bone is unlike that of the Laetoli Hominid 18, the Eyasi I and the Kabwe skull in that it is much broader, more curved and unkeeled. The Omo I frontal bone presents with a shallow ophryonic groove, as in the Laetoli Hominid 18 cranium, and the degree of the development of the supra-orbital torus and the glabella is probably similar. In the Omo 2, the frontal bone is very flattened and keeled resembling that of the Laetoli Hominid 18, but the general bone morphology in these two crania differs. The Omo 2 frontal, unlike that of the Laetoli Hominid 18, presents with massively developed supra-orbital torus and there is substantial outcurving of the anterior temporal lines with no ophryonic groove. In this respect, the frontal bone of the Omo 2 shows similarities to that of the Kabwe and Saldanha crania though the bone is much broader than in the latter two specimens. The frontal portion of the Florisbad, unlike that of the Laetoli Hominid 18, Eyasi I, Kabwe, Saldanha and Omo 2, is much more broader and curved. However, the frontal bone in the Florisbad skull shows some resemblances to that of the Kabwe, Saldanha and Omo 2 in the supra-orbital and glabella development, together with the outcurving of the anterior temporal lines. The Iwo Eleru frontal bone, like that of the Laetoli Hominid 18 cranium is flattened and receding but with no ophryonic groove nor keeling.

The sub-Saharan *Homo erectus* such as the O.H. 9 together with the Pekin *Homo erectus* crania present with quite different frontal bone morphology compared to that of the Laetoli Hominid 18 cranium. Thus, the frontal bone in *Homo erectus* as a whole is markedly flattened, narrow with marked sagittal crests. The supra-orbital torus, together with the glabella are massively developed while the anterior temporal lines are more outcurving and with deep temporal fossae.

The European classic Neanderthaler crania such as the La Chapelle-aux-Saints, La Ferrassie, Spy I and 2 have relatively more curved and expanded frontals, unlike that of the Laetoli Hominid 18. Resembling the European classic Neanderthaler crania in the frontal bone morphology are the Middle East early *Homo sapiens* crania such as the Tabūn I and the Skhūl 5 crania.

Anatomically modern *Homo sapiens* such as the sub-Saharan modern, unlike the Laetoli Hominid 18, have relatively curved and high frontals with varying degrees of frontal bossing. Closer to the sub-Saharan modern crania in the frontal bone morphology are the Matjes River, Fish Hoek, Singa, Djebel Irhoud, Kafzeh 9 and Keilor I crania.

From the anatomical comparisons of the frontal bone in the different hominid fossils and modern crania, the following conclusions can be drawn:

(i) The Laetoli Hominid 18 cranium shows some resemblance in frontal bone morphology to a number of early African *Homo sapiens* crania including the Eyasi I, Kabwe, Omo I, Omo 2, Saldanha, Florisbad and the Iwo Eleru.

(ii) The frontal bone morphology in general, seems to distinguish between most of the early African *Homo sapiens* crania and the modern *Homo sapiens*, the African *Homo erectus*, the Pekin *Homo erectus*, the Middle East early *Homo sapiens*, the Far East/Australia early *Homo sapiens* and the early European Neanderthaler crania.

C. THE PARIETAL BONE MORPHOLOGY OF THE LAETOLI HOMINID 18 CRANIUM COMPARED WITH OTHER HOMINID FOSSILS AND MODERN CRANIA

The Laetoli Hominid 18 cranium presents with rectangular parietals with post-bregmatic and pre-lambdoid flattening. Posteriorly, the parietals are moderately rounded and present with well developed and centrally situated parietal eminences. The parietal bone profile of the Laetoli Hominid 18 cranium closely resembles that of a number of early African hominid fossils including the Eyasi I, Omo I and probably the Florisbad skulls. The Eyasi I and Omo I specimens differ slightly from the

Laetoli Hominid 18 parietal bone profile in the absence of pre-lambdoid flattening.

The Kabwe, Singa, Saldanha and the Omo 2 skulls, together with the Djebel Irhoud crania, seem to have similar parietal bone profiles characterised by marked flattening. However, the above specimens differ considerably in certain other aspects of parietal bone morphology. The Kabwe parietals like those of the Laetoli Hominid 18 cranium, present with pre-lambdoid flattening, together with diffuse and centrally situated parietal eminences. The Singa, on the other hand, presents with strong parietal eminences and with a broad inter-parietal depression, whereas the Omo 2 has a keeled sagittal profile with well developed and superiorly situated parietal eminences.

The O.H.9 calvarium, unlike the Laetoli Hominid 18 cranium, seems to have longitudinally flattened parietals and resemble those of the Pekin *Homo erectus* crania. However, the Pekin *Homo erectus* crania, unlike the O.H.9 present with keeled parietals and with interparietal grooves.

The European classic Neanderthaler crania including the La Chapelle-aux-Saints, Spy 2 and Gibraltar seem to be flattened, laterally broadened and with mid-height parietal eminences. Closely resembling the European classic Neanderthaler crania in parietal bone morphology are the Middle East early *Homo sapiens* crania including the Tabūn I and Amud I crania.

The sub-Saharan modern crania seem to have relatively elevated, more curved parietals and with well developed tubera. Resembling the anatomically modern *Homo sapiens* crania in parietal bone morphology are several crania of the later Upper Pleistocene crania that include, the Fish Hoek, Matjes River, Iwo Eleru, Skhūl 5, Kafzeh 9 and Keilor I skulls.

From the parietal bone profile, the following conclusions can be drawn:

1. The parietal bone profile significantly separates the different hominid crania ranging from *Homo erectus* to the anatomically modern.

2. The Laetoli Hominid 18 cranium together with the Omo I, Eyasi I and possibly Florisbad, seem to differ considerably in parietal bone profile from most of the early African *Homo sapiens* crania including the Kabwe, Omo 2, Saldanha and the Singa.

D. THE OCCIPITAL BONE PROFILE OF THE LAETOLI HOMINID 18 CRANUM COMPARED WITH OTHER HOMINID FOSSILS AND MODERN CRANIA

The occipital profile of the Laetoli Hominid 18 cranium presents with an evenly rounded, well filled occipital bone with a well developed undercut and centrally situated occipital torus. In this respect, the occipital profile of the Laetoli Hominid 18 cranium shows some

similarities to a number of early African *Homo sapiens* crania that include the Omo I, Eyasi I and the Iwo Eleru crania. Apart from the early African *Homo sapiens* crania, the Laetoli Hominid 18 cranium also shows some resemblances to the sub-Saharan modern crania in the general morphology of the occipital bone. The sub-Saharan modern crania, in occipital bone profile, resemble other crania such as the Singa, Djebel Irhoud, Kafzeh 9, Wadjak I, Keilor I, Tabūn I and Swanscombe crania all of which have ill-defined occipital tori.

The Kabwe, Omo 2 and the O.H.9 crania, unlike the Laetoli Hominid 18 cranium, are characterised by an angulated occiput with markedly developed tori extending towards the mastoid regions.

The European classic Neanderthaler crania, like the La Chapelle-aux-Saints, La Ferrassie, Le Moustier, Spy I and 2 skulls, unlike the Laetoli Hominid 18 are characterised by bun-shaped occiputs with centrally limited occipital tori.

The following conclusions can be drawn from the occipital bone profile in the different Hominid crania studied:

1. There seems to be no specificity in the pattern of the occipital bone profile in the different Hominid groups studied.
2. The Laetoli Hominid 18 cranium resembles the Omo I, Eyasi I, Singa, and Iwo Eleru skulls and the sub-

Saharan modern group in occipital bone morphology. The Laetoli Hominid 18 cranium also shows some similarities to a number of fossil crania from other localities outside Africa, including the Skhūl 5, Kafzeh 9, Tabūn I, Amud I, Keilor I, Gibralter and Swanscombe.

E. THE TEMPORAL BONE MORPHOLOGY OF THE LAETOLI HOMINID 18 CRANIUM COMPARED WITH OTHER FOSSIL HOMINID AND MODERN CRANIA.

The morphological appearance of the temporal bone of the Laetoli Hominid 18 cranium, though low set on the cranium, is essentially of modern type. The bone however differs from the modern in a number of features including the development of the mastoid process, the development of the occipitomastoid crest and the possession of a widened digastric groove.

(i) The size of the mastoid process: In the Laetoli Hominid 18 cranium, the mastoid processes are small. In this respect, the cranium differs from modern *Homo sapiens* crania that have well developed mastoids. The small size of the mastoids is a feature also seen in a number of crania studied here and include, the Eyasi I, Singa, Iwo Eleru, Djebel Irhoud, Fish Hoek and Matjes River. This feature is also seen in a number of classic European Neanderthaler crania such as the La Chapelle-aux-Saints, La Ferrassie and Gibraltar. The Tabūn I cranium from the Middle East also presents with small mastoid processes.

(ii) The occipitomastoid crests: The Laetoli Hominid 18 cranium presents with a well developed occipito-mastoid crest (preserved only the right side) that is well separated from the mastoid process by a deep mastoid groove. In this respect, the Laetoli Hominid 18 cranium differs from the modern *Homo sapiens* crania with ill-defined occipitomastoid crests and also differs from the rest of the early African *Homo sapiens* crania studied here. Fossil crania with marked occipitomastoid crests include the La Ferrassie, La Chapelle-aux-Saints, Gibraltar, Swanscombe, Steinheim, Tabūn I and Shanidar I, although this latter specimen was not included in this study.

(iii) Mandibular fossae: The mandibular fossae in the Laetoli Hominid 18 cranium are essentially of modern type. These are large and deep. They differ from those in the Pekin *Homo erectus* crania with deep but narrow fossae but resemble those in Solo I, and Omo 2, Kabwe and the La Ferrassie crania.

(iv) Supramastoid crests: The supramastoid crests in the Laetoli Hominid 18 cranium are only moderately marked as in modern *Homo sapiens* crania. The Omo 2, Kabwe and the O.H.9 skulls, unlike the Laetoli Hominid 18 cranium, have well developed supramastoid crests.

F. THE FACIAL SKELETON OF THE LAETOLI HOMINID 18 CRANIUM COMPARED WITH OTHER FOSSIL HOMINIDS AND MODERN CRANIA

The facial skeleton of the Laetoli Hominid 18 cranium is only moderately developed and closely resembles the modern *Homo sapiens* crania. It was unfortunate that most of the comparative fossil crania lack the facial skeleton, thus this comparison was mainly made on the Kabwe cranium and on the classic Neanderthaler crania as a whole. The facial skeleton in the Kabwe cranium, unlike that of the Laetoli Hominid 18 cranium is large and long. The orbits as in the Laetoli Hominid 18 are large and deep but unlike the latter, the inter-orbital distance is much wider in the Kabwe cranium. The nasofrontal process of the maxilla in the Kabwe cranium are expanded and the nasal aperture is broad, rounded and with no nasal spine. The malar bones in the Kabwe cranium are massive and low set while in the Laetoli Hominid 18 cranium these are only moderately developed and are higher up. The maxillae in the Kabwe cranium, unlike in the Laetoli Hominid 18 cranium, are large, inflated and with no canine fossae. The palate is U-shaped, deep and broader than in the Laetoli Hominid 18 cranium. In addition, the Kabwe cranium, unlike the Laetoli Hominid 18 cranium, presents with a marked degree of alveolar prognathism. The Classic Neanderthals, on the other hand, unlike the Laetoli Hominid 18 cranium, present with peculiar features of the facial skeleton. In these, the facial skeleton is large and wide with large round and widely open orbits. The

nose is broad and projecting and the cheek bones are retreating.

G. THE ENDOCRANIAL CAST OF THE LAETOLI HOMINID 18 CRANIUM

Due to the completeness of the cranial bones of the Laetoli Hominid 18 cranium, it was possible to obtain a good endocranial cast. It was however difficult to obtain access to sufficient endocranial casts for comparative purposes. The general inferences from the endocranial cast of the Laetoli Hominid 18 cranium all favour features of modern *Homo sapiens* crania. Thus, in general appearance, the cast gives an impression of an "ill-filled" skull. This last feature is also shown in the endocranial casts of some modern skulls (Le gros Clark, 1964). The lateral view of the endocranial cast of the Laetoli Hominid 18 cranium shows a flattened sagittal contour of the cerebral hemisphere and in this respect it resembles the endocranial cast of the Omo 2 cranium. The posterior view of the endocranial cast of the Laetoli Hominid 18 cranium shows a rounded occipital pole as in modern *Homo sapiens* crania; the cast is widest in the region of the temporal eminences, as is often the case in the endocranial casts of modern crania and of the Omo 2. The dural venous sinuses correspond closely to those observed in modern human crania. The pattern of the meningeal vessels as shown on the endocranial cast

also correspond closely to those of modern *Homo sapiens* crania. Two sets of the vascular pattern are clearly shown on the endocranial cast. One set of the vessels consists of the frontal branch of the middle meningeal vessels and runs up vertically immediately behind the coronal suture and supplying the region around the bregma and the anterior part of the parietal region. The second set of vessels consists of the parietal branch of the middle meningeal vessels which also runs upwards and posteriorly giving out several branches as it does so. This parietal branch of the middle meningeal vessels supplies the region around the lambda and the central part of the parietals. The estimated endocranial capacity of about 1200 cc comes well within the range of variation of modern *Homo sapiens* crania.

Summary of the anatomical comparisons

As revealed from the anatomical comparisons, the Laetoli Hominid 18 cranium shows a combination of both archaic and modern features (Table 3). Thus, the cranium is closer to the modern *Homo sapiens* crania in the shape of the maxillae, the depth of the palate, the shape of the nasal aperture, the posterior profile of the parietal bones, the profile of the occipital bone and in the general development of the cerebral vascular vessels. The archaic features of the Laetoli Hominid 18 cranium include the flattening and recession of the frontal

region, the development of the brow ridges, the development of the occipital torus, the small size of the mastoid processes and the development of the occipito-mastoid crest.

Although morphologically the Laetoli Hominid 18 cranium shows a complex of features, nevertheless, the cranium shows some resemblances to some of the early African *Homo sapiens* crania including, the Kabwe, Eyasi I, Omo I, Omo 2, Saldanha, Iwo Eleru, Florisbad and Singa. The morphological evidence suggests that although there are some differences between the Laetoli Hominid 18 cranium with the above mentioned early African *Homo sapiens* crania, still the cranium fits well within this range. This morphological relatedness of the early African *Homo sapiens* crania mentioned above seems to suggest that the continent of Africa was at one time occupied by a single population that may have spread in various localities. Due to a complex of unexplained factors this early African *Homo sapiens* population in turn show a diversity of skull form and within each skull are further complex features demonstrating the mosaic type of evolution.

Morphologically, the Laetoli Hominid 18 cranium is differentiated from the European, Middle East and Far East/Australia early *Homo sapiens* crania and from the African and the Pekin *Homo erectus* crania.

TABLE 3. Advanced and Archaic features of the Laetoli Hominid 18 cranium.

Advanced Features	Archaic features
1. Overall expansion of the cranial vault.	1. Low, receding, flattened and slightly keeled frontal
2. Bossing of the parietal bones.	2. Large brow ridges.
3. Roundness and fullness of the occipital region	3. Low marked temporal ridges.
4. Lowness of the inion	4. Bone thickness.
5. Shape of the dental arcade	5. Small mastoids
6. Depth of the palate	6. Developed occipitomastoid crests.
7. Pear-shaped nasal opening with a possible nasal spine	7. Developed, undercut and centrally limited occipital torus.
8. Development of the branches of the middle meningeal vessels.	
9. Cranial capacity of 1200 cc (average)	

The general conclusion drawn from this morphological comparison is that the Laetoli Hominid 18 cranium is archaic and differs from the modern *Homo sapiens* crania. The cranium shows strong morphological links with some of the early African *Homo sapiens* crania but differs greatly from the other early *Homo sapiens* crania from either Europe, Middle East, Asia or Australia.

2. RESULTS OF THE METRICAL ANALYSES

A maximum of 27 cranial measurements were taken and recorded for the Laetoli Hominid 18 cranium (Table 4). Similar measurements were also taken from all of the comparative cranial materials (Tables 7-9). Additional measurements of bone thickness and of preserved teeth were also taken from the Laetoli Hominid 18 cranium and are listed in Tables 5-6. The means, minima, maxima and standard deviations for the individual measurements for the whole sample and for the separate groups are shown in Tables 10 and 11 respectively.

As mentioned earlier, three methods of metrical analyses were used in this study and included, the univariate, bivariate and multivariate methods. The results of these methods are given below.

TABLE 4. Cranial measurements of the Laetoli Hominid 18.
(All measurements in millimeters)

Number		Measurement
(1)	Nasion-bregma arc (FA)	125.0
(2)	Bregma-lambda arc (PA)	132.0
(3)	Bregma-asterion arc (BAA)	159.0
(4)	Glabello-occipital length (GOL)	205.0
(5)	Nasion-occipital length (NOL)	205.0
(6)	Maximum cranial breadth (XCB)	140.0
(7)	Maximum frontal breadth (XFB)	112.0
(8)	Nasion-bregma chord (FRC)	117.0
(9)	Nasion-bregma subtense (FRS)	19.0
(10)	Nasion subtense fraction (FRF)	64.0
(11)	Bregma-lambda chord (PAC)	122.0
(12)	Bregma-lambda subtense (PAS)	20.0
(13)	Bregma-subtense fraction (PAF)	52.0
(14)	Bifrontal breadth (FMB)	105.0
(15)	Nasio-frontal subtense (NAS)	24.0
(16)	Glabella projection (GLS)	5.0
(17)	Supraorbital projection (SOS)	9.0
(18)	Interorbital breadth (DKB)	27.8
(19)	Minimum cranial breadth (WCB)	98.9
(20)	Bistephanic breadth (STB)	92.2
(21)	Bregma-asterion chord (BAC)	136.7
(22)	Biasterionic breadth (ASB)	123.7
(23)	Biauricular breadth (AUB)	127.0
(24)	Mastoid Height (MHT)	24.6
(25)	Mastoid Width (MWD)	11.6
(26)	Palate breadth (External) (MAB)	74.2
(27)	Vertex Radius (VRR)	119.0

TABLE 5. Measurements of bone thickness of the Laetoli Hominid 18 cranium.
(All measurements in millimeters)

Frontal bone	Left side	13.0
	Right side	10.0
Mid-parietal bone	Left side	13.0
	Right side	12.0
Parietal bone Near Asterion	Left side	12.0
	Right side	12.0

TABLE 6. Measurements of the teeth of the Laetoli Hominid 18 cranium.
(All measurements in millimeters)

		I^1	I^2	C	P^3	P^4	M^1	M^2	M^3
Left	Buccal/Lingual	-	-	-	-	Roots only	11.5	-	10.5
	Mesial/Distal	-	-	-	-		10.0	-	10.0
Right	Buccal/Lingual	-	-	-	9.5	9.8	12.5	-	-
	Mesial/Distal	-	-	-	7.0	7.0	10.8	-	-

TABLE 7. Cranial measurements of the sub-Saharan modern, sub-Saharan early Upper Pleistocene, sub-Saharan later Upper Pleistocene, sub-Saharan *Homo erectus* and North African Upper Pleistocene groups.

(All measurements in millimeters)

Number	Measurement	Material											
		O.H.9	Kabwe	Omo 1	Omo 2	Singa	Iwo Eleru	Floris-bad	Saldanha	Fish Hoek	Matjes River	Djebel Irhoud	sub-Saharan modern
(1)	FA	117.0	135.0	137.0		129.0	105.0	113.0	130.0	141.0	125.0	133.0	126.4
(2)	PA	-	125.0	130.0	125.0	98.0	139.0	140.0	120.0	140.0	125.0	111.0	128.7
(3)	BAA	145.0	160.0	178.0	159.0	169.0	-	-	162.0	159.0	156.0	169.0	159.0
(4)	GOL	205.0	206.0	210.0	215.0	190.0	199.0	202.0	199.0	200.0	178.0	198.0	183.9
(5)	NOL	196.0	200.0	208.0		189.0	201.0	200.0	197.0	195.0	176.0	194.0	181.8
(6)	XCB	149.0	146.0	144.0	146.0	154.0	150.0	151.0	-	151.0	140.0	152.0	133.2
(7)	XFB	110.0	117.0		121.0	122.0	120.0	133.0	114.0	118.0	123.0	130.0	113.7
(8)	FRC	103.0	120.0	125.0	124.3	115.0	94.0	111.0	116.0	122.0	106.0	117.0	111.5
(9)	FRS	12.0	21.0			24.0	16.0	21.0	17.0	30.0	31.0	27.0	27.3
(10)	FRF	61.0	65.0			52.0	48.0	50.0	52.0	47.0	44.0	43.0	48.6
(11)	PAC	-	118.0	124.0	119.0	94.0	129.5	127.0	109.0	130.0	117.0	107.0	115.7
(12)	PAS	-	18.0		17.0	14.0	26.0	22.0	20.0	28.0	22.0	13.0	25.1
(13)	PAF	-	61.0		80.0	52.0	73.0	69.0	51.0	67.0	67.0	61.0	61.5
(14)	FMB	134.0	127.0	122.0	117.0	110.0	96.0	130.0	117.0	103.0	100.0	117.0	100.8
(15)	NAS	25.0	28.0				14.0	27.0	27.0	18.0	14.0	22.0	18.5
(16)	GLS	11.0	9.0	4.0		2.0	3.0	6.0	5.0	6.0	3.0	7.0	2.0
(17)	SOS	20.5	15.5	3.0		17.0	7.0	12.0	18.0	10.5	4.5	10.0	5.6
(18)	DKB	29.5	27.3	32.0		28.8	28.5	33.7		28.0	22.2	28.0	25.5
(19)	WCB	87.6	102.4	109.0	107.0	104.2	96.8	120.0	100.0	107.1	94.8	106.9	96.6
(20)	STB	-	111.8		112.7	111.0	105.2	122.5	106.4	122.4	118.5	119.7	111.0
(21)	BAC	134.0	138.7	151.3	136.5	135.9	-	-	132.0	136.5	131.8	139.0	132.7
(22)	ASB	132.8	-		138.0	123.3	-	-	-	129.6	120.7	121.5	105.5
(23)	AUB	137.0	-		130.9	130.0	132.3	-	-	123.8	122.8	141.1	112.8
(24)	MHT	-	29.2	28.0		23.6	21.7	-	-	20.0	25.6	22.6	28.8
(25)	MWD	22.0	18.1	13.5	13.8	11.7	14.2	-	-	7.3	10.6	10.0	10.3
(26)	MAB	-	78.0	-	-	-	-	67.1	-	61.2	63.2	73.0	63.8
(27)	VRR	112.0	-	-	125.0	120.0	-	-	-	120.0	112.0	-	123.0

TABLE 8. Cranial measurements of the Middle East early Upper Pleistocene, Middle East later Upper Pleistocene and European early Upper Pleistocene groups.

(All measurements in millimeters

		Material								
Number	Measurement	Tabun 1	Skhul 5	Amud 1	Kafzeh 9	Chapelle	Ferrassie	Spy 1	Spy 2	Moustier
(1)	FA	108.0	116.0	133.0	122.0	123.0	136.0	120.0	135.0	126.0
(2)	PA	115.0	138.0	119.0	144.0	119.0	118.0	128.0	114.0	127.0
(3)	BAA	149.5	165.5	160.0	165.0	165.0	-	-	-	142.0
(4)	GOL	183.0	190.0	210.0	192.0	210.0	206.0	-	200.0	198.0
(5)	NOL	181.0	180.0	208.0	190.0	205.0	-	-	-	190.0
(6)	XCB	143.0	144.0	153.0	138.0	157.0	157.0	145.0	157.0	153.0
(7)	XFB	127.0	112.0	124.0	116.0	128.0	122.0	118.0	126.0	-
(8)	FRC	97.0	100.0	122.0	112.0	110.0	-	106.0	123.0	105.0
(9)	FRS	22.0	22.0	25.0	-	25.0	-	16.0	26.0	27.0
(10)	FRF	51.0	49.0	60.0	-	65.0	-	56.0	65.0	53.0
(11)	PAC	106.0	124.0	114.0	131.0	112.0	104.0	116.0	108.0	114.0
(12)	PAS	20.0	28.0	17.0	-	19.0	19.0	23.0	18.0	26.0
(13)	PAF	51.0	63.0	61.0	-	51.0	56.0	56.0	-	65.0
(14)	FMB	107.0	112.0	114.0	108.0	115.0	111.0	121.0	-	113.0
(15)	NAS	15.0	11.0	28.0	20.0	26.0	-	26.0	-	-
(16)	GLS	6.0	11.0	6.0	5.0	12.0	-	10.0	10.0	9.0
(17)	SOS	6.0	8.0	14.5	11.0	16.0	16.0	12.0	13.0	10.0
(18)	DKB	35.0	30.0	31.0	27.7	31.0	-	35.0	-	29.0
(19)	WCB	100.0	102.0	113.6	103.2	110.7	109.0	104.6	110.7	111.0
(20)	STB	122.1	108.2	124.0	112.0	117.5	-	110.7	117.3	-
(21)	BAC	124.3	138.3	137.3	136.5	137.3	-	-	-	137.3
(22)	ASB	116.2	124.1	-	110.0	-	-	-	-	126.0
(23)	AUB	138.7	127.3	135.7	120.4	139.5	142.0	-	-	146.0
(24)	MHT	18.6	29.5	-	24.8	-	-	-	-	-
(25)	MWD	8.8	14.6	-	11.1	-	-	-	-	-
(26)	MAB	69.3	67.6	75.8	68.3	-	76.3	-	-	-
(27)	VRR	105.0	119.0	-	-	-	-	-	-	-

TABLE 9. Cranial measurements of the Pekin *Homo erectus* and the Far East/Australia Upper Pleistocene groups.

(All measurements in millimeters)

		Material						
Number	Measurement	PKLE2	PKLL1	PKLL2	PKLL3	Solo 1	Wadjak 1	Keilor 1
(1)	FA	110.0	120.0	112.0	120.0	130.0	104.0	126.0
(2)	PA	99.0	115.0	96.0	95.0	112.0	156.0	142.0
(3)	BAA	139.0	150.0	142.0	147.0	152.5	-	-
(4)	GOL	190.0	196.0	192.0	194.0	196.0	205.0	198.0
(5)	NOL	186.0	197.0	186.0	191.0	188.0	200.0	195.0
(6)	XCB	145.0	142.0	144.0	137.0	150.0	-	143.0
(7)	XFB	104.0	108.0	106.0	108.0	123.0	-	126.0
(8)	FRC	103.3	112.0	105.0	113.0	116.0	94.0	116.0
(9)	FRS	20.0	19.0	22.0	19.0	21.0	18.0	25.0
(10)	FRF	45.0	60.0	49.0	65.0	53.0	48.0	44.0
(11)	PAC	96.0	91.0	92.0	91.0	105.0	139.0	132.0
(12)	PAS	11.0	11.0	14.0	11.0	19.0	-	27.0
(13)	PAF	61.0	55.0	41.0	51.0	59.0	-	51.0
(14)	FMB	-	-	-	-	-	115.0	107.0
(15)	NAS	-	-	-	-	-	20.0	22.2
(16)	GLS	10.0	7.0	8.0	7.0	6.0	8.0	3.0
(17)	SOS	9.0	12.0	8.0	12.0	8.0	7.0	10.0
(18)	DKB	33.0	33.5	-	33.5	30.0	30.0	31.0
(19)	WCB	82.0	89.5	89.3	92.2	-	99.7	100.3
(20)	STB	89.3	104.0	88.3	98.6	116.5	109.6	117.0
(21)	BAC	121.2	129.0	121.0	129.3	130.0	-	-
(22)	ASB	118.0	115.0	-	117.1	102.0	-	-
(23)	AUB	139.4	-	141.5	-	-	136.5	-
(24)	MHT	-	-	-	-	31.0	-	-
(25)	MWD	-	-	-	-	6.3	-	-
(26)	MAB	-	-	-	-	-	71.0	71.8
(27)	VRR	-	-	-	-	-	-	-

TABLE 10. Means, minima, maxima and standard deviations of the individual measurements for the whole sample.

Number	Measurement	Mean	Minimum	Maximum	Standard deviation
(1)	FA	123.0	104.0	141.0	10.1
(2)	PA	124.1	95.0	156.0	15.4
(3)	BAA	156.7	138.0	178.0	9.7
(4)	GOL	197.6	178.0	215.0	8.9
(5)	NOL	192.9	176.0	208.0	9.3
(6)	XCB	147.1	132.0	157.0	7.1
(7)	XFB	119.7	110.0	133.0	6.5
(8)	FRC	109.9	94.0	125.0	8.5
(9)	FRS	22.0	12.0	31.0	4.6
(10)	FRF	53.6	42.0	65.0	7.8
(11)	PAC	113.9	91.0	139.0	12.8
(12)	PAS	20.0	11.0	28.0	5.0
(13)	PAF	59.0	41.0	80.0	8.6
(14)	FMB	113.6	96.0	134.0	9.6
(15)	NAS	21.5	11.0	28.0	5.3
(16)	GLS	6.6	2.0	12.0	2.8
(17)	SOS	11.2	3.0	18.0	4.3
(18)	DKB	29.5	21.0	35.0	3.6
(19)	WCB	101.0	82.0	120.0	8.7
(20)	STB	106.7	88.0	124.0	17.6
(21)	BAC	133.2	121.0	151.0	6.4
(22)	ASB	119.7	102.0	138.0	9.7
(23)	AUB	132.0	112.0	146.0	8.9
(24)	MHT	25.4	18.6	29.2	3.5
(25)	MWD	11.9	6.3	18.1	3.0
(26)	MAB	69.3	61.2	76.3	5.3
(27)	VRR	117.3	107.0	125.0	6.4

TABLE 11. Means, minima, maxima and standard deviations of the individual measurements for the separate groups.

Group	Variable											
	Nasion bregma arc (1)				Bregma lambda arc (2)				Bregma asterion arc (3)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
Sub-Saharan early Upper Pleistocene (1)	128.8	113.0	137.0	9.4	123.0	98.0	140.0	14.0	165.6	159.0	178.0	6.0
Sub-Saharan later Upper Pleistocene (2)	123.7	105.0	141.0	18.0	134.7	125.0	140.0	8.4	157.5	156.0	159.0	6.3
Middle East early Upper Pleistocene (3)	120.5	108.0	133.0	17.7	117.0	115.0	119.0	2.8	154.8	149.5	160.0	6.5
Middle East later Upper Pleistocene (4)	119.0	116.0	122.0	4.2	141.0	138.0	144.0	4.2	165.3	165.0	165.5	6.1
Pekin *Homo erectus* (5)	116.4	110.0	120.0	5.0	101.3	95.0	115.0	9.3	144.5	139.0	150.0	6.9
Far East/Australia Upper Pleistocene (6)	115.0	104.0	126.0	15.6	149.0	142.0	156.0	9.9	152.0			
European early Upper Pleistocene (7)	128.0	120.0	136.0	7.2	121.2	114.0	128.0	6.1	153.5	142.0	165.0	6.5
Laetoli Hominid 18 (8)	125.0				132.0				159.0			
Sub-Saharan modern (9)	126.0	110.0	144.0	3.5	128.7	106.0	147.0	2.4	159.0			
North African Upper Pleistocene (10)	133.0				110.0				169.0			
Sub-Saharan *Homo erectus* (11)	117.0								145.0			

... Cont'd...

TABLE 11...cont'd...

Group	Variable											
	Glabello-occipital length (4)				Nasion occipital length (5)				Maximum cranial breadth (6)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	201.4	190.0	210.0	7.6	198.8	189.0	208.0	5.0	149.3	146.0	154.0	3.9
(2)	192.3	178.0	200.0	12.4	190.7	176.0	201.0	5.2	147.0	140.0	151.0	6.1
(3)	196.5	183.0	210.0	19.1	196.5	183.0	210.0	5.1	148.0	143.0	153.0	7.1
(4)	191.0	190.0	192.0	1.4	185.0	180.0	190.0	5.2	141.0	138.0	144.0	4.2
(5)	194.0	190.0	196.0	2.6	190.0	186.0	197.0	5.3	142.0	137.0	145.0	3.6
(6)	201.5	198.0	205.0	4.9	194.3	188.0	200.0	5.1	143.0			
(7)	203.5	200.0	210.0	5.5	197.5	198.0	210.0	5.1	153.8	145.0	157.0	5.2
(8)	205.0				205.0				140.0			
(9)	183.9	164.0	203.0	4.8	181.8				133.2	121.0	149.0	3.1
(10)	198.0				194.0				152.0			
(11)	205.0				196.0				149.0			

... cont'd ...

TABLE 11...cont'd ...

Group	Variable											
	Maximum frontal breadth (7)				Nasion bregma chord (8)				Nasion bregma subtense (9)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	121.4	110.0	133.0	7.2	117.4	110.0	125.0	5.3	20.7	17.0	24.0	4.8
(2)	120.3	118.0	123.0	2.5	107.3	94.0	122.0	14.0	25.7	16.0	31.0	3.9
(3)	125.5	124.0	127.0	2.1	109.3	97.0	122.0	17.7	23.5	22.0	25.0	4.3
(4)	114.0	112.0	116.0	2.8	106.0	100.0	112.0	8.5	22.0			
(5)	106.5	104.0	108.0	1.9	108.3	103.3	113.0	5.0	20.0	19.0	22.0	5.0
(6)	126.0				105.0	94.0	116.0	15.6	21.3	18.0	25.0	4.6
(7)	123.5	118.0	128.0	4.4	111.0	110.0	123.0	8.3	23.5	16.0	27.0	4.3
(8)	112.0				117.0				19.0			
(9)	113.7	100.6	132.0	2.9	111.5	98.0	127.0	2.3	27.0			
(10)	130.0				117.0				27.0			
(11)	110.0				103.0				12.0			

... cont'd ...

TABLE 11... cont'd...

Group	Variable											
	Nasion subtense fraction (10)				Bregma lambda chord (11)				Bregma lambda subtense (12)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	54.8	50.0	65.0	1.8	115.2	94.0	129.5	12.1	18.2	17.0	22.0	5.5
(2)	46.3	44.0	48.0	2.1	122.2	117.0	130.0	8.2	25.3	22.0	28.0	3.9
(3)	55.5	51.0	60.0	1.8	110.0	106.0	114.0	5.7	18.5	17.0	20.0	5.4
(4)	49.0				127.5	124.0	131.0	4.9	28.0			
(5)	54.8	45.0	65.0	1.8	92.5	91.0	96.0	2.4	11.8	11.0	14.0	8.5
(6)	48.3	44.0	53.0	2.1	135.5	132.0	139.0	4.9	23.0	19.0	27.0	4.3
(7)	59.8	56.0	65.0	1.7	110.8	108.0	116.0	4.8	21.0	19.0	26.0	4.8
(8)	64.0				122.0				20.0			
(9)	48.6				115.7	98.0	133.0	3.2	25.1			
(10)	43.0				107.0				13.0			
(11)	61.0											

... cont'd ...

TABLE 11... cont'd ...

Group	Variable: Bregma subtense fraction (13)				Bifrontal breadth (14)				Nasion frontal subtense (15)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	62.6	51.0	80.0	4.2	120.5	110.0	130.0	8.3	24.0	27.0	28.0	4.2
(2)	69.0	67.0	73.0	1.4	99.6	96.0	103.0	1.0	15.3	14.0	18.0	6.5
(3)	56.0	51.0	61.0	1.8	110.5	107.0	114.0	9.0	21.5	15.0	28.0	4.7
(4)	63.0				110.0	108.0	112.0	9.1	15.5	11.0	20.0	6.5
(5)	52.0	41.0	61.0	1.9								
(6)	55.0	51.0	59.0	1.8	111.0	107.0	115.0	9.0	21.1	20.0	22.2	4.7
(7)	57.0	51.0	65.0	1.8	115.0	108.0	121.0	8.7	26.0	26.0	26.0	3.8
(8)	52.0				105.0				24.0			
(9)	61.5				100.8				18.5			
(10)	61.0				117.0				22.0			
(11)					134.0				25.0			

... cont'd ...

TABLE 11... cont'd...

Group	Variable											
	Glabella Projection (16)				Supraorbital projection (17)				Interorbital projection (18)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	5.2	2.0	9.0	2.6	13.1	3.0	18.0	5.8	30.5	27.3	33.7	2.9
(2)	3.7	3.0	6.0	2.1	7.3	4.5	10.5	3.0	26.2	22.2	28.5	3.5
(3)	6.0	6.0	6.0	0.0	10.3	6.0	14.5	6.0	33.0	31.0	35.0	2.8
(4)	8.0	5.0	11.0	4.2	9.5	8.0	11.0	2.1	28.9	27.7	30.0	1.6
(5)	8.0	7.0	10.0	1.4	10.3	8.0	12.0	2.1	33.3	33.0	33.5	0.4
(6)	5.5	3.0	8.0	3.5	8.5	7.0	10.0	2.1	30.5	30.0	31.0	0.7
(7)	10.3	10.0	12.0	1.3	12.8	12.0	16.0	2.5	31.0	31.0	35.0	2.8
(8)	5.0				9.0				27.8			
(9)	2.0	1.0	6.0	0.2	5.6	3.0	10.0	0.6	25.5	18.4	32.9	1.2
(10)	7.0				10.0				28.0			
(11)	11.0				20.5				29.5			

... cont'd ...

TABLE 11... cont'd ...

Group	Variable											
	Minimum cranial breadth (19)				Bistephanic breadth (2)				Bregma asterion chord (21)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	107.1	100.0	120.0	9.3	112.8	106.4	122.5	8.7	138.9	135.9	151.3	7.2
(2)	99.6	94.8	107.1	1.0	115.3	105.2	122.4	8.7	134.2	131.8	136.5	7.5
(3)	106.8	100.0	113.6	9.4	123.1	122.1	124.0	8.1	130.8	124.3	137.3	7.6
(4)	102.6	102.0	103.2	9.7	110.1	108.2	112.0	9.1	137.4	136.5	138.3	7.2
(5)	88.3	82.0	92.2	1.1	96.7	88.3	104.0	1.0	125.1	121.0	129.3	7.9
(6)	100.0	99.7	100.3	1.0	114.4	109.6	117.0	8.7	130.0			
(7)	109.2	104.6	111.0	9.2	115.2	110.7	117.7	8.7	137.2	137.3	137.3	7.3
(8)	98.9				92.2				136.7			
(9)	96.6				111.0				132.7			
(10)	106.9				119.7				139.0			
(11)	87.6								134.0			

TABLE 11... cont'd ...

Group	Variable											
	Biasterionic breadth (22)				Biauricular breadth (23)				Mastoid Height (24)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	130.7	123.3	138.0	7.7	130.5	130.0	130.9	7.7	26.9	23.6	29.2	3.7
(2)	125.2	120.7	129.6	8.0	126.3	122.8	123.0	7.9	22.4	20.0	25.6	4.5
(3)	116.2				137.2	135.7	138.7	7.3	18.0			
(4)	117.1	110.0	124.1	8.5	123.9	120.4	127.3	8.1	27.2	24.8	29.5	3.6
(5)	116.7	115.0	118.0	8.6	140.5	139.4	141.5	7.1				
(6)	102.0				136.5				31.0			
(7)	126.0				142.5	139.5	146.0	7.0				
(8)	123.7				127.0				24.6			
(9)	105.5				112.8				28.8			
(10)	121.5				141.1				22.6			
(11)	132.8				137.0							

... cont'd ...

TABLE 11... cont'd ...

Group	Variable											
	Mastoid width (25)				Palate breadth (26)				Vertex Radius (27)			
	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.	MN	MIN	MAX	S.D.
(1)	14.3	11.7	18.1	6.9	72.6	67.1	78.0	1.4	122.5	120.0	125.0	8.2
(2)	10.7	7.3	10.6	9.3	62.2	61.2	63.2	1.6	116.0	112.0	120.0	8.6
(3)	8.8				72.6	69.3	75.8	1.4	105.0			
(4)	12.9	11.1	14.6	7.8	67.7	67.6	68.3	1.5	119.0			
(5)												
(6)	6.3					71.0	71.8					
(7)					76.3							
(8)	11.6				74.2				119.0			
(9)	10.3				63.8				123.0			
(10)	10.0				73.0							
(11)	22.0								112.0			

(a) Univariate Analyses

The univariate analyses comprised the metrical comparisons of the individual measurements of the Laetoli Hominid 18 cranium with the corresponding measurements of the comparative materials. This procedure proved difficult on occasion as some of the comparative materials lacked measurements corresponding to those of the Laetoli Hominid 18; this resulted in some inconsistency in the number of the specimens used in the analyses. This variability in the sample size posed a major problem indeed as it very much influenced the results of these analyses. Thus, the chosen groups with smaller sample sizes often presented with very much inflated ranges as compared to those with larger sample sizes. As a whole the results of the univariate analyses though perhaps easier to interpret, may be less reliable than those of the other two methods, the bivariate and multivariate analyses.

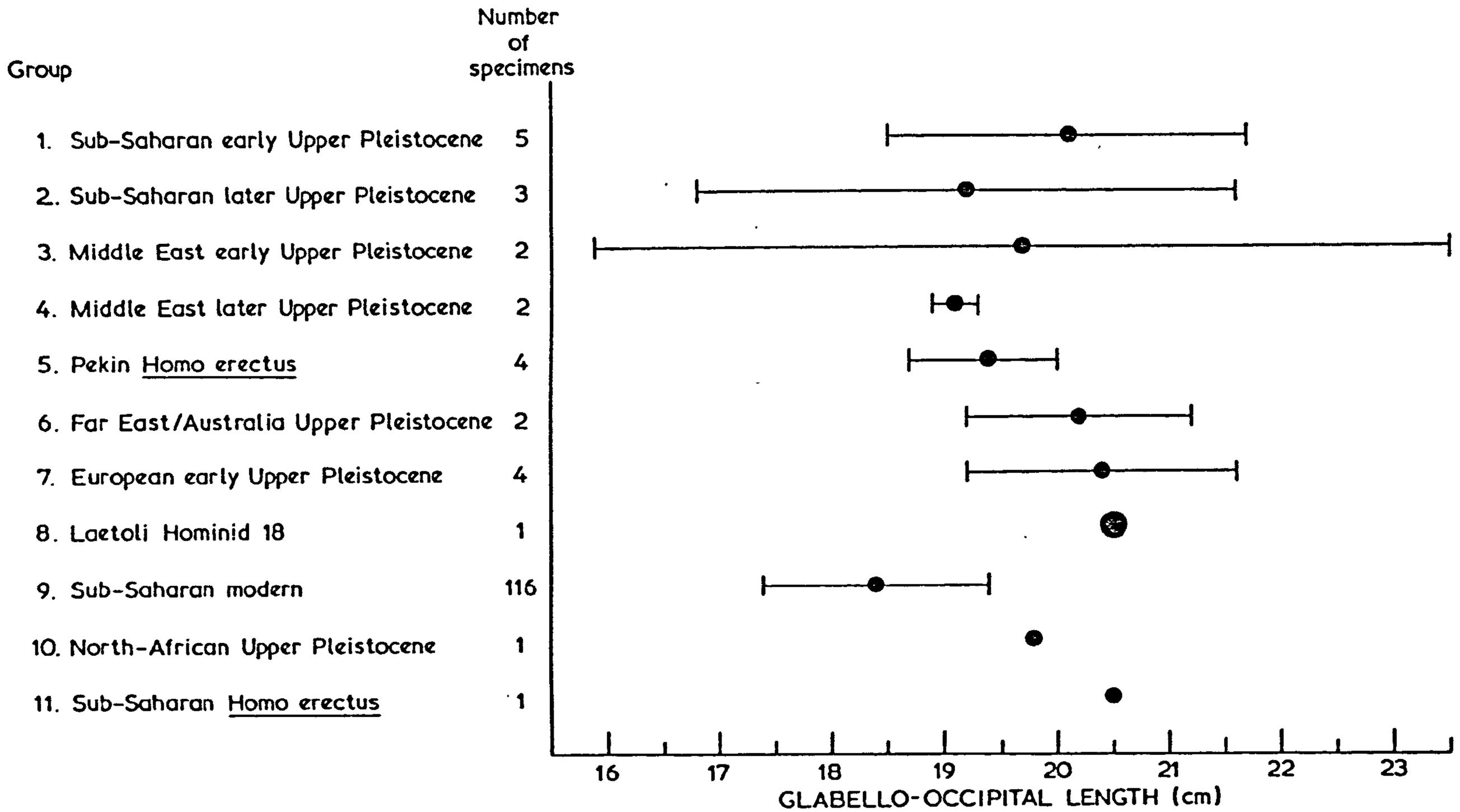
The same grouping of the materials as shown in Table 1 was used in the univariate analyses. The groups were divided on the basis of their geographical distribution and supposed chronology and included; (1) the sub-Saharan early Upper Pleistocene, (2) the sub-Saharan later Upper Pleistocene, (3) the Middle East early Upper Pleistocene, (4) the Middle East later Upper Pleistocene, (5) the Pekin *Homo erectus*, (6) the Far East/ Australia Upper Pleistocene, (7) the European early Upper Pleistocene, (8) the Laetoli Hominid 18 cranium,

(9) the sub-Saharan modern, (10) the North African Upper Pleistocene and (11) the sub-Saharan *Homo erectus* crania.

A total of 14 out of the original 27 cranial measurements were considered in the univariate analyses and included; the glabello-occipital length (variable 4), the maximum cranial breadth (6), the maximum frontal breadth (7), the nasion bregma chord (8), the nasion bregma subtense (9), the bregma lambda chord (11), the bregma lambda subtense (12), the bifrontal breadth (14), the glabella projection (16), the supraorbital projection (17), the interorbital breadth (18), the minimum cranial breadth (19), the biasterionic breadth (22) and the biauricular breadth (23).

(i) The glabello-occipital length: Figure 4 shows the means and ranges within two standard deviations (on either side of the means) of the glabello-occipital length for the hominid groups considered. The glabello-occipital length of the Laetoli Hominid 18 is identical to that of the sub-Saharan *Homo erectus* group and is closer to the mean positions of the European early Upper Pleistocene, Far East/Australia Upper Pleistocene and the sub-Saharan early Upper Pleistocene groups. The highest range in the glabello-occipital length (75.5) is shown by the Middle East early Upper Pleistocene group. The sub-Saharan later Upper Pleistocene group also shows a relatively high range (46.5) in this variable. The high range shown in the above two groups probably reflects the

FIGURE 4: Plot of the glabello-occipital length: Laetoli Hominid 18 cranium compared with other hominid groups.



small sample size (n = 2) and (n = 3) respectively, and also may be due to high within group variability or the presence of more than one group. The range in the glabello-occipital length in the sub-Saharan modern group is (17.5), this is particularly low. As the data is based upon fairly large samples (n = 116), it may suggest strong stabilising selection for this variable in this group. The glabello-occipital length means for the sub-Saharan later Upper Pleistocene and the Middle East later Upper Pleistocene groups are almost identical and fall within the range of the sub-Saharan modern group.

As a whole, the plot of the glabello-occipital length reveals that in this variable, Laetoli Hominid 18 lies within the range of the more archaic hominid groups like the sub-Saharan *Homo erectus* and the European early Upper Pleistocene and is well separated from sub-Saharan modern group.

(ii) The maximum cranial breadth: Figure 5 shows the means and the ranges within two standard deviations (on either side of the means) of the maximum cranial breadth for the hominid groups. The sub-Saharan early Upper Pleistocene, the sub-Saharan later Upper Pleistocene, the Middle East early Upper Pleistocene, the Middle East later Upper Pleistocene and the Pekin *Homo erectus* groups show considerable overlap of their estimated group ranges. However, the mean positions and the ranges for the Middle East later Upper Pleistocene and for the Pekin *Homo erectus*

groups are identical (15.5). Also showing almost identical mean positions are the sub-Saharan early Upper Pleistocene, the sub-Saharan later Upper Pleistocene and the Middle East early Upper Pleistocene groups. The maximum cranial breadth for the Laetoli Hominid 18 is close to the mean positions of the Pekin *Homo erectus* and the Middle-East later Upper Pleistocene groups and is slightly outside the range of two standard deviations for the sub-Saharan modern group. The mean positions for the European early Upper Pleistocene group as well as the positions of the sub-Saharan *Homo erectus* and the North African Upper Pleistocene groups are well separated from the rest of the groups.

In general terms, the maximum cranial breadth of the Laetoli Hominid 18 as revealed from Figure 5 lies intermediate between that of the sub-Saharan modern group and the more archaic *Homo sapiens* groups but is closer to the former group.

(iii) The minimum cranial breadth: Figure 6 shows the means and the ranges within two standard deviations (on either side of the means) of the minimum cranial breadth for the hominid groups. As with the maximum cranial breadth, considerable range is shown by the sub-Saharan early Upper Pleistocene, sub-Saharan later Upper Pleistocene and the Middle East early Upper Upper Pleistocene groups. The minimum cranial breadth for the Laetoli Hominid 18 is almost identical to the

FIGURE 5: Plot of the maximum cranial breadth: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 6: Plot of the minimum cranial breadth: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 5

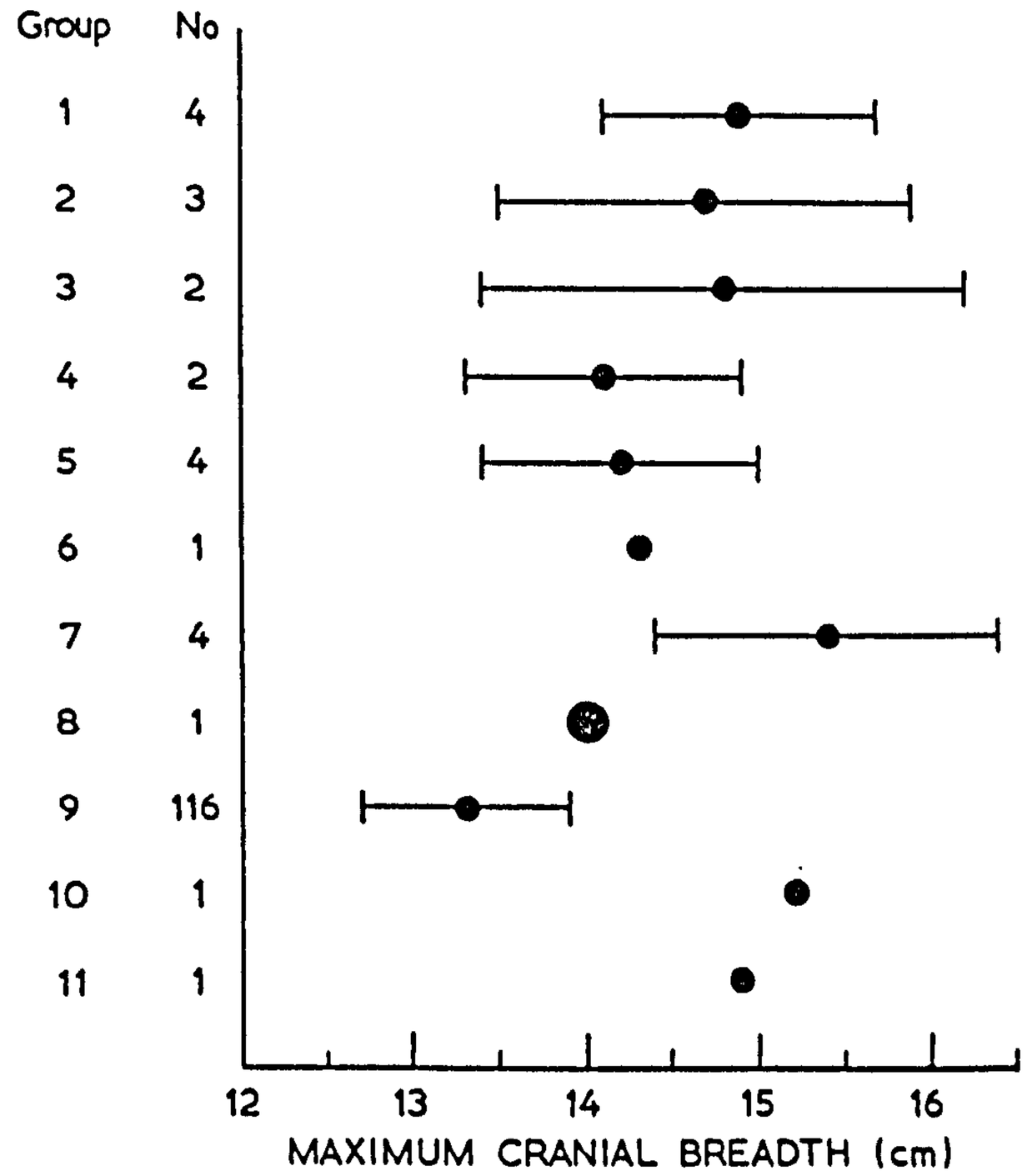
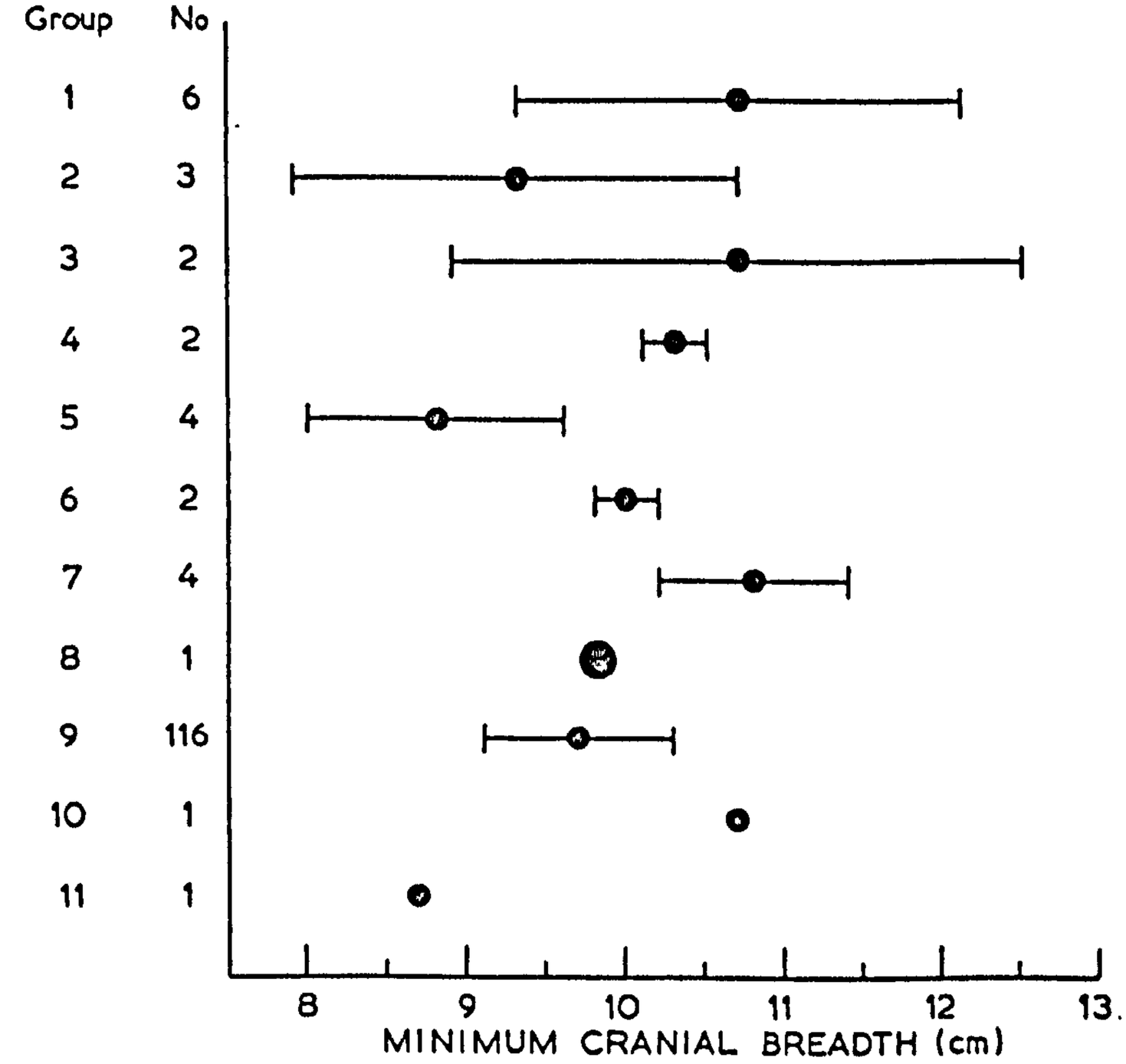


FIGURE 6



mean positions for the sub-Saharan modern, the Far East/ Australia Upper Pleistocene and the Middle East later Upper Pleistocene groups. The mean positions for the Pekin *Homo erectus* and the sub-Saharan *Homo erectus* groups lie outside two standard deviation ranges of the sub-Saharan Modern group. Similar separation is also shown by the mean positions of the European early Upper Pleistocene and the North African Upper Pleistocene groups.

Considering the minimum cranial breadth alone, the Laetoli Hominid 18 cranium lies within the range of the sub-Saharan modern group as are the Far East/Australia Upper Pleistocene and the Middle East later Upper Pleistocene groups.

(iv) The maximum frontal breadth: Figure 7 shows the means and the ranges within two standard deviations (on either side of the means) of the maximum frontal breadth for the hominid groups. The higher range (26.5) is shown by the sub-Saharan early Upper Pleistocene group, the rest of the groups show low ranges. The maximum frontal breadth for the Laetoli Hominid 18 is almost identical to the mean positions of the European early Upper Pleistocene and the Middle East later Upper Pleistocene groups and is within the range of two standard deviations of the sub-Saharan modern group. The Pekin *Homo erectus* group has a mean position well outside that of two standard deviations range of the sub-Saharan modern group as is the Middle East early Upper Pleistocene

group. The mean positions for the sub-Saharan early Upper Pleistocene and that of the sub-Saharan later Upper Pleistocene are almost similar. As a whole, the maximum frontal breadth of the Laetoli Hominid 18 is within the range of the sub-Saharan modern group.

(v) The interorbital breadth: Figure 8 shows the means and the ranges within two standard deviations (on either side of the means) of the interorbital breadth for the hominid groups. Nearly all of the groups show low ranges. The interorbital breadth of the Laetoli Hominid 18 is identical to the North African Upper Pleistocene group and to the mean position of the Middle East later Upper Pleistocene group, and falls within the range of two standard deviations of the sub-Saharan modern group. The mean position of the Pekin *Homo erectus* group is well outside the sub-Saharan modern group but lies within the ranges of the sub-Saharan early Upper Pleistocene, the Middle East early Upper Pleistocene and the European early Upper Pleistocene groups.

(vi) The bifrontal breadth: Figure 9 shows the means and the ranges within two standard deviations (on either side of the means) of the bifrontal breadth. The mean positions of the sub-Saharan modern and the sub-Saharan later Upper Pleistocene groups are almost identical to the Middle East early and later Upper Pleistocene groups. The bifrontal breadth of the Laetoli Hominid 18 lies between the sub-Saharan modern group and

FIGURE 7: Plot of the maximum frontal breadth: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 8: Plot of the interorbital breadth: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 7

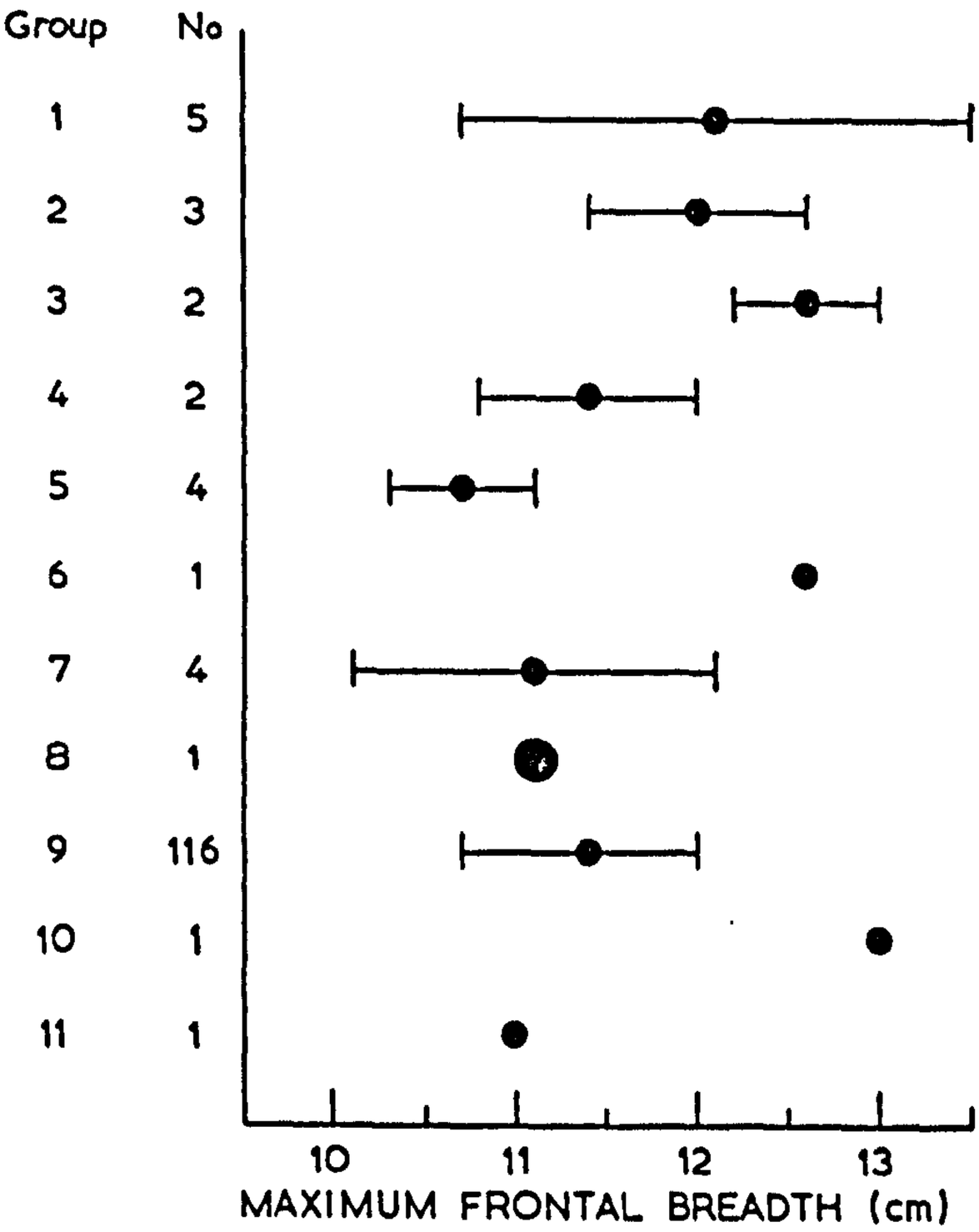
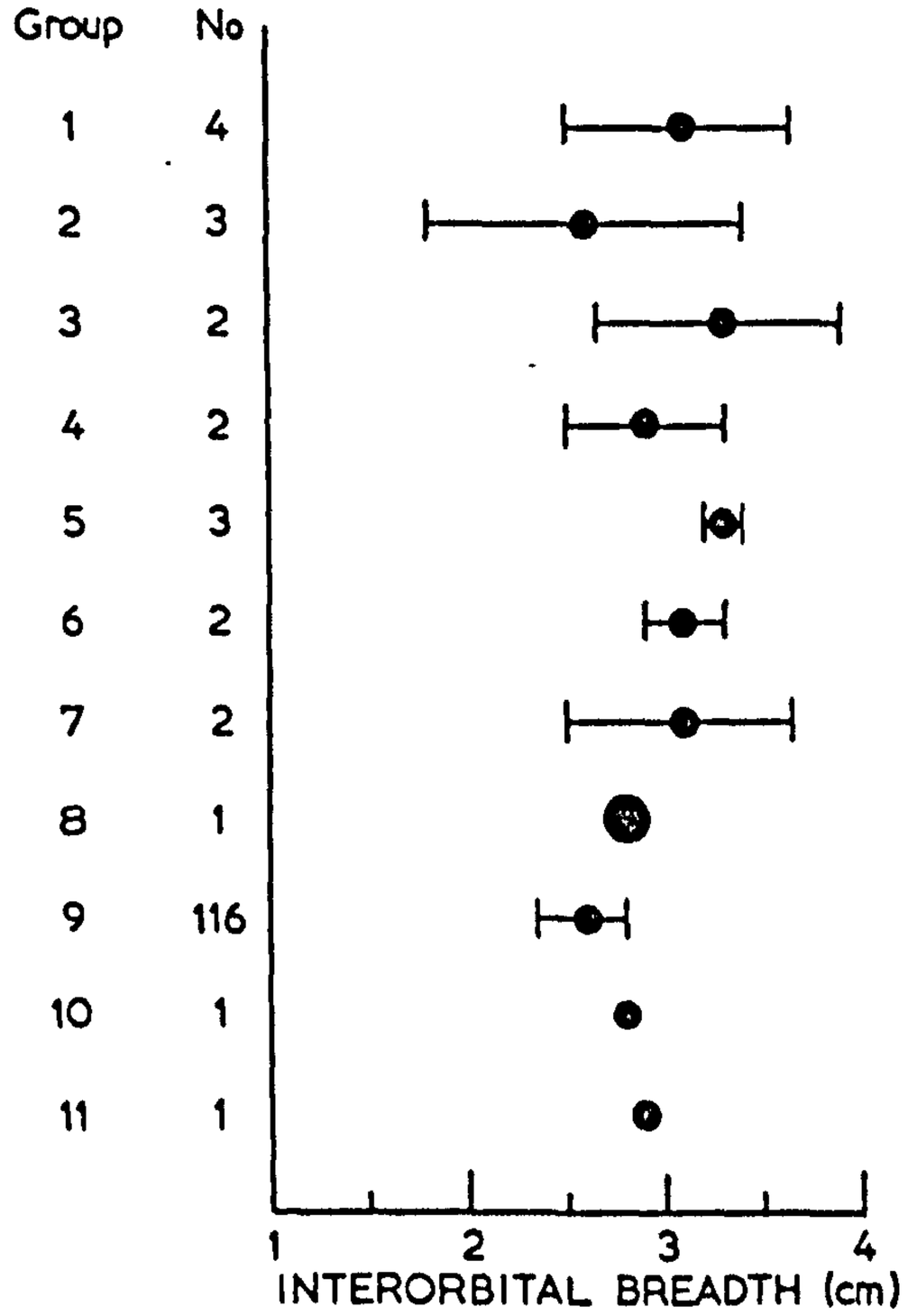


FIGURE 8



the European early Upper Pleistocene and the Middle East later Upper Pleistocene groups. The sub-Saharan *Homo erectus* group lies well outside the range of the sub-Saharan modern group.

(vii) The biauricular breadth: Figure 10 shows the means and the ranges within two standard deviations (on either side of the means) of the biauricular breadth for the hominid groups. Almost all of the groups show low ranges. The mean positions for the sub-Saharan later Upper Pleistocene and of the Middle East later Upper Pleistocene groups are almost identical. The biauricular breadth of the Laetoli Hominid 18 lies within the ranges of the sub-Saharan later Upper Pleistocene and the Middle East later Upper Pleistocene groups. This is well outside the range of two standard deviations of the sub-Saharan modern group. The mean positions of the Middle East early Upper Pleistocene, the Pekin *Homo erectus*, the European early Upper Pleistocene and the sub-Saharan *Homo erectus* groups also lie well outside the range of two standard deviations of the sub-Saharan modern group. As a whole the plot of the biauricular breadth reveals that Laetoli Hominid 18 lies intermediate between the sub-Saharan modern and the more archaic *Homo sapiens* groups.

(viii) The biasterionic breadth: Figure 11 shows the means and the ranges within two standard deviations

FIGURE 9: Plot of the bifrontal breadth: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 10: Plot of the biauricular breadth of the Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 9

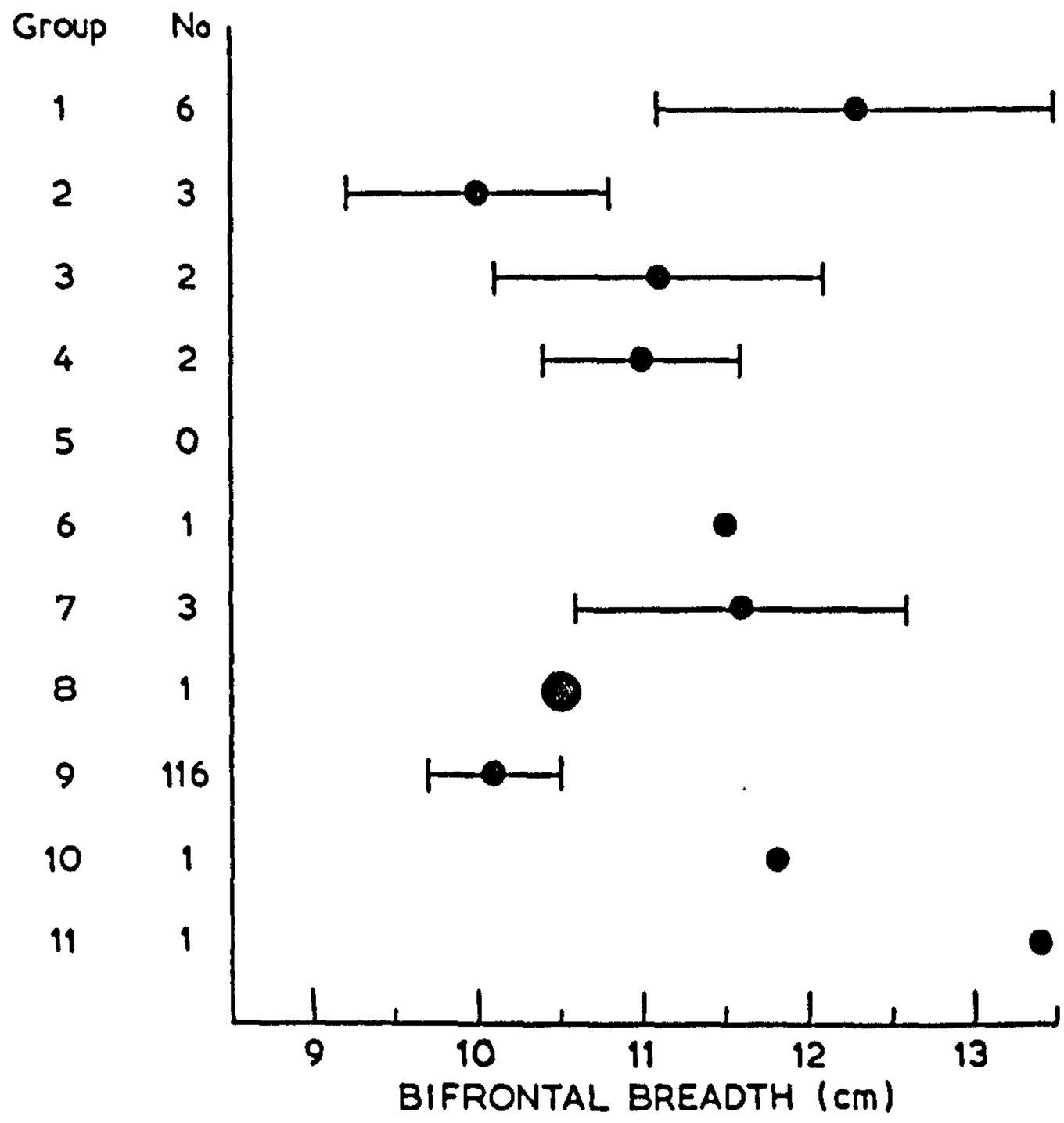
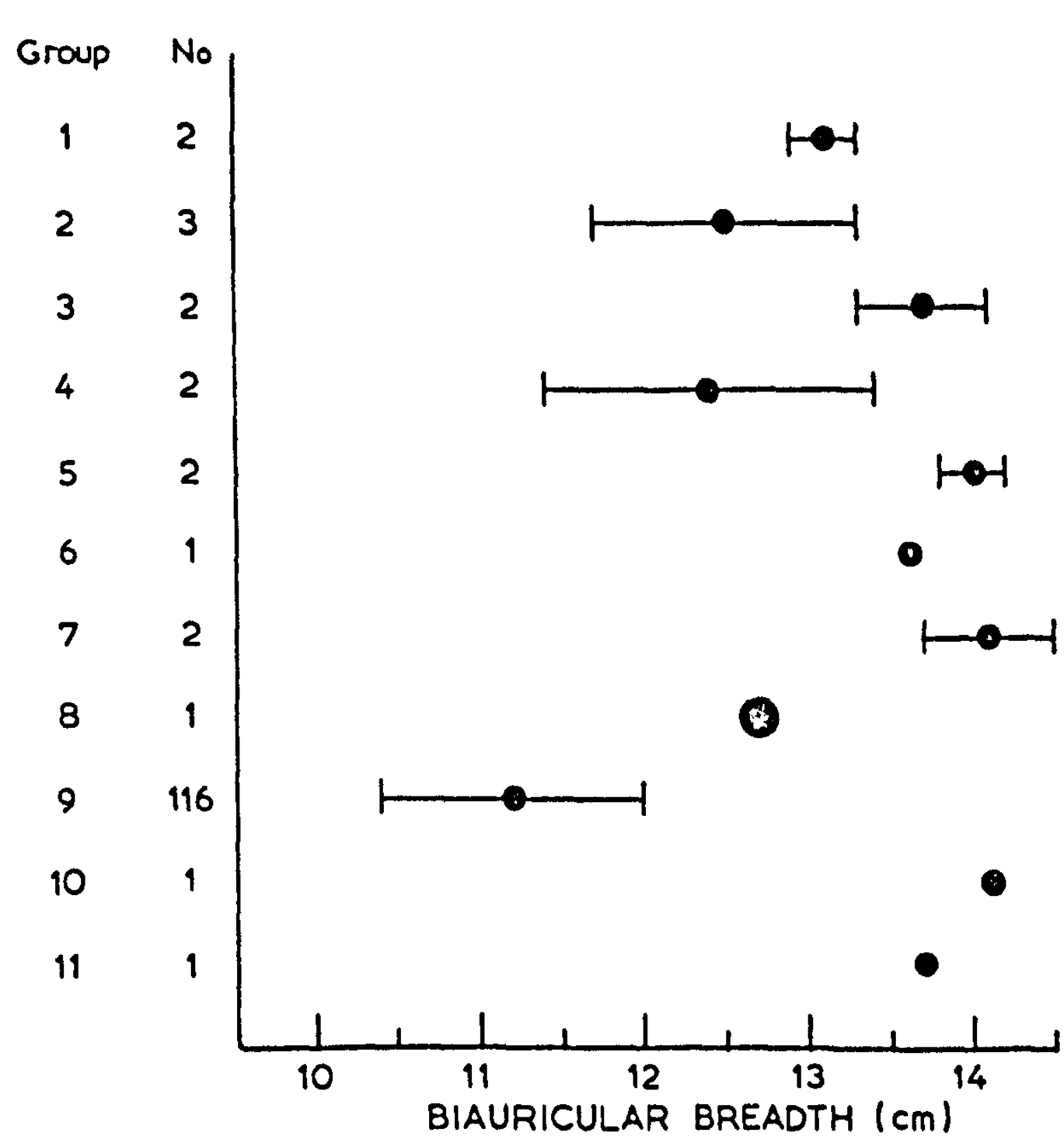


FIGURE 10



(on either side of the means) of the biasterionic breadth for the hominid groups. The highest ranges are shown by the sub-Saharan early Upper Pleistocene group (42) and the Middle East later Upper Pleistocene group (37.5). The high ranges shown in these groups may reflect the small size sample of (n = 2) in each of the groups or might be due to high within group variability or the presence of more than one population. The mean positions of all of the fossil materials lie well outside that of the sub-Saharan modern group. The Pekin *Homo erectus* group shows almost identical mean position with the Middle East later Upper Pleistocene group. Laetoli Hominid 18 has almost identical biasterionic breadth with the North African Upper Pleistocene group and is almost similar to the mean position for the sub-Saharan later Upper Pleistocene group. The biasterionic breadth of the sub-Saharan *Homo erectus* group is well outside the mean positions of most of the groups but lies within the ranges of the sub-Saharan early Upper Pleistocene, the sub-Saharan later Upper Pleistocene and the Middle East later Upper Pleistocene groups.

(ix) The nasion bregma chord: Figure 12 shows the means and the ranges within two standard deviations (on either side of the means) of the nasion-bregma chord. Almost all of the fossil hominid groups considered show high ranges. The highest range is shown by Middle East early Upper Pleistocene group (71) and is followed by the

FIGURE 11: Plot of the biasterionic breadth: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 12: Plot of the nasion bregma chord: Laetoli Hominid 18 cranium compared with other hominid crania.

FIGURE 11

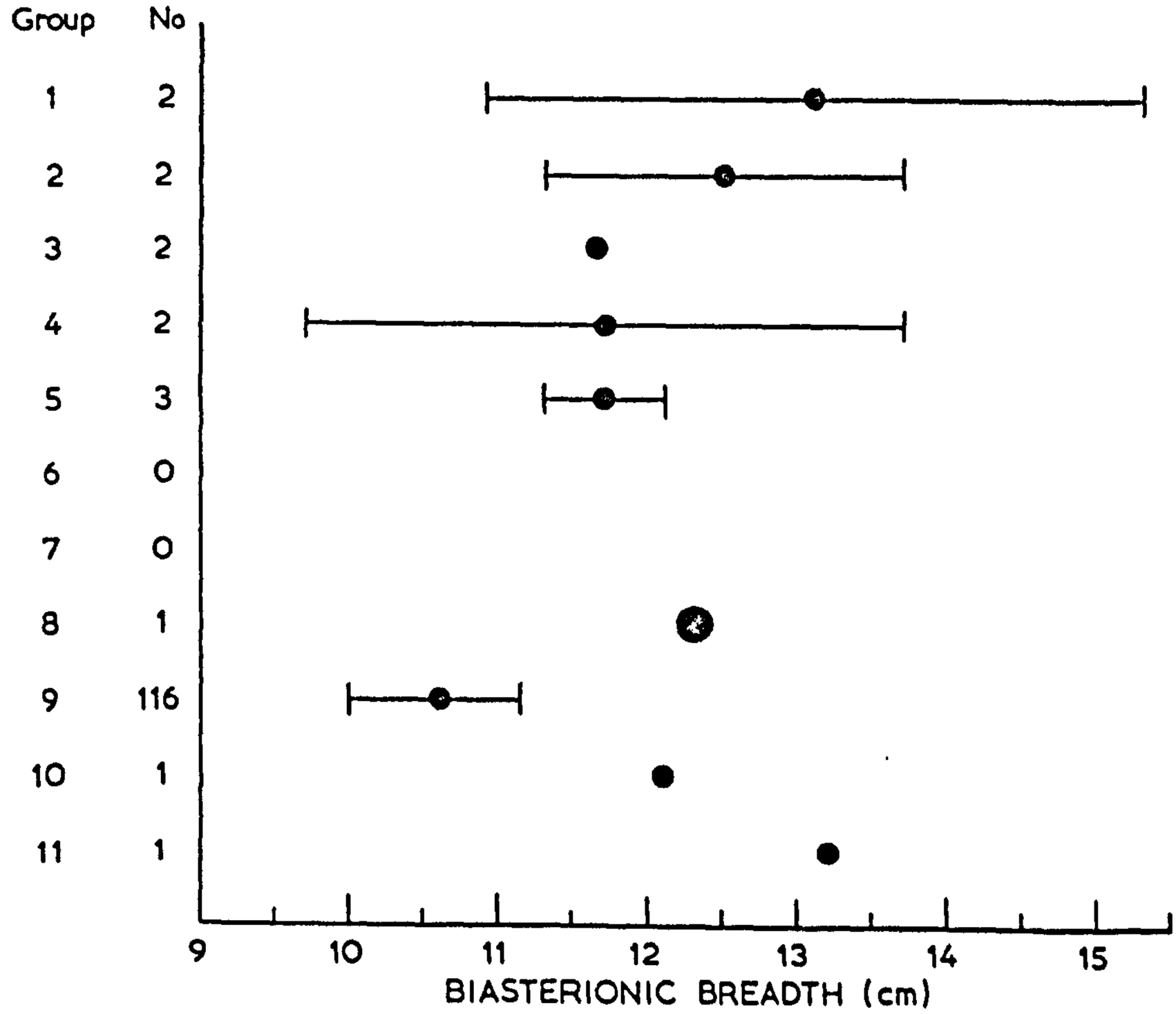
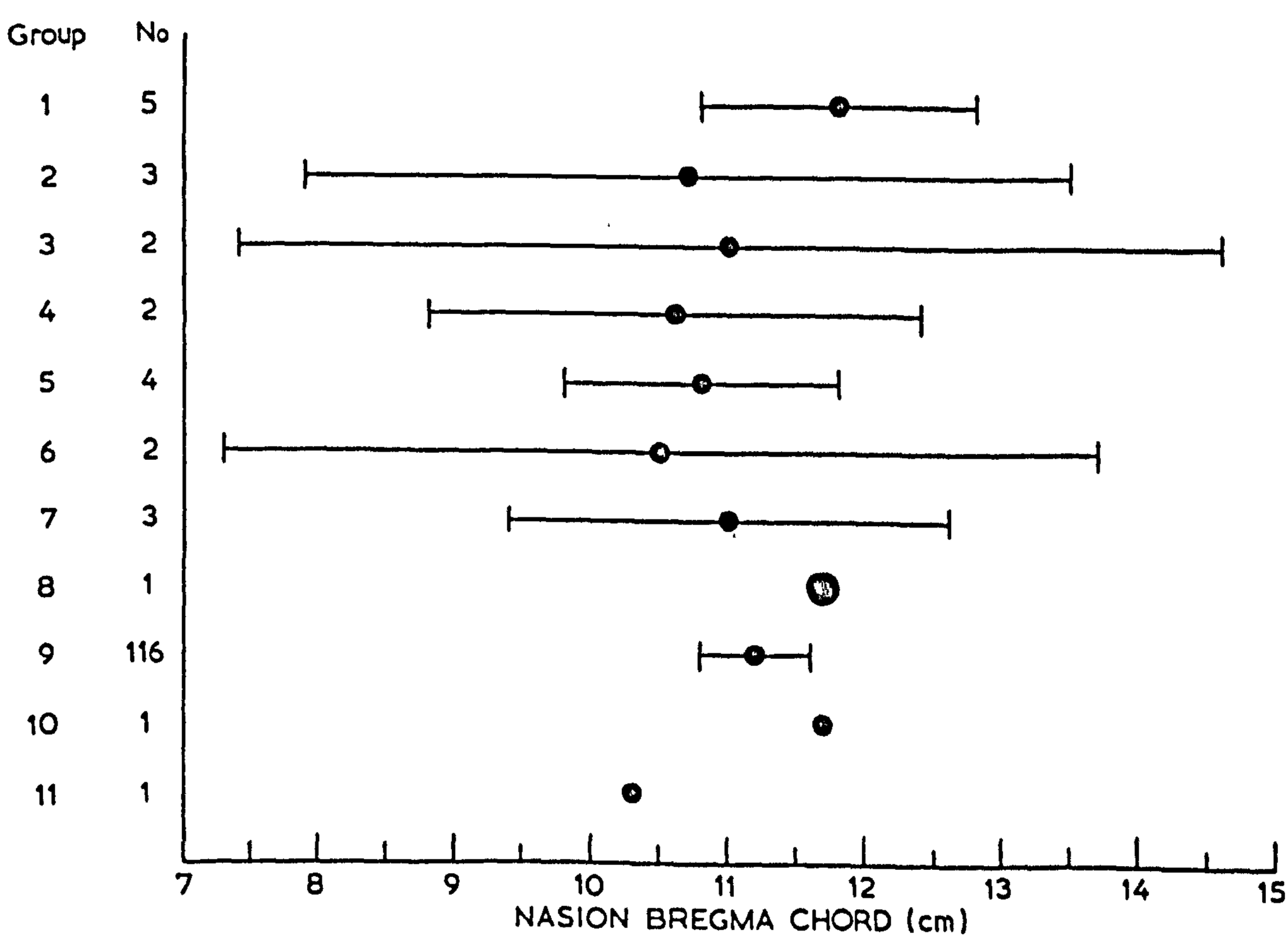


FIGURE 12



Far East/Australia Upper Pleistocene group (62) and by the sub-Saharan later Upper Pleistocene group (55.5). The probable explanation for this high range in these groups for this variable may be the small sample size and the within group variability or the presence of more than one population in the group. The sub-Saharan Modern group shows a low range (6.5). This range is well overlapped within those of the Middle East early Upper Pleistocene, Middle East later Upper Pleistocene, sub-Saharan early Upper Pleistocene, sub-Saharan later Upper Pleistocene, Pekin *Homo erectus*, Far East/Australia Upper Pleistocene and the European early Upper Pleistocene groups. Likewise, Laetoli Hominid 18 is also overlapped within the above mentioned groups.

(x) The nasion bregma subtense: Figure 13 shows the means and the ranges within two standard deviations (on either side of the means) of the nasion bregma subtense. Unlike the nasion bregma chord the groups show low ranges of the nasion bregma subtense variable. The highest range is shown by the sub-Saharan later Upper Pleistocene group (31). The sub-Saharan modern shows the lowest range of (2). The mean positions for the European early Upper Pleistocene, the Far East/Australia Upper Pleistocene, the Middle East early and later Upper Pleistocene and the sub-Saharan early Upper Pleistocene groups are almost identical. Laetoli Hominid 18 lies well outside the two standard deviations range of the

sub-Saharan modern group but is clearly within the ranges of the sub-Saharan early and later Upper Pleistocene, the Middle East early and later Upper Pleistocene, the Pekin *Homo erectus*, the Far East/Australia Upper Pleistocene and the European early Upper Pleistocene groups. The North African Upper Pleistocene has an identical mean position to the sub-Saharan modern group. The two groups are in turn overlapped by the ranges of the European early Upper Pleistocene, the Far East/Australia Upper Pleistocene and the sub-Saharan later Upper Pleistocene groups. The sub-Saharan *Homo erectus* group is well outside the two standard deviations range of the sub-Saharan modern group.

(xi) The bregma lambda chord: Figure 14 shows the means and the ranges within two standard deviations (on either side of the means) of the bregma-lambda chord of the hominid groups. As in the nasion-bregma chord, the hominid groups show high ranges in the bregma-lambda measurement. The highest range is shown by the sub-Saharan early Upper Pleistocene group (44) and is followed by the sub-Saharan later Upper Pleistocene group (27). The mean positions for the sub-Saharan early Upper Pleistocene, sub-Saharan later Upper Pleistocene, the Middle East early Upper Pleistocene and the European early Upper Pleistocene are almost identical and fall well outside the range of the sub-Saharan modern group. The lowest range is again shown by the sub-Saharan modern group (11). Laetoli Hominid 18 lies intermediate between

FIGURE 13: Plot of the nasion bregma subtense: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 14: Plot of the bregma lambda chord: Laetoli Hominid 18 cranium compared with other hominid groups.

FIGURE 13

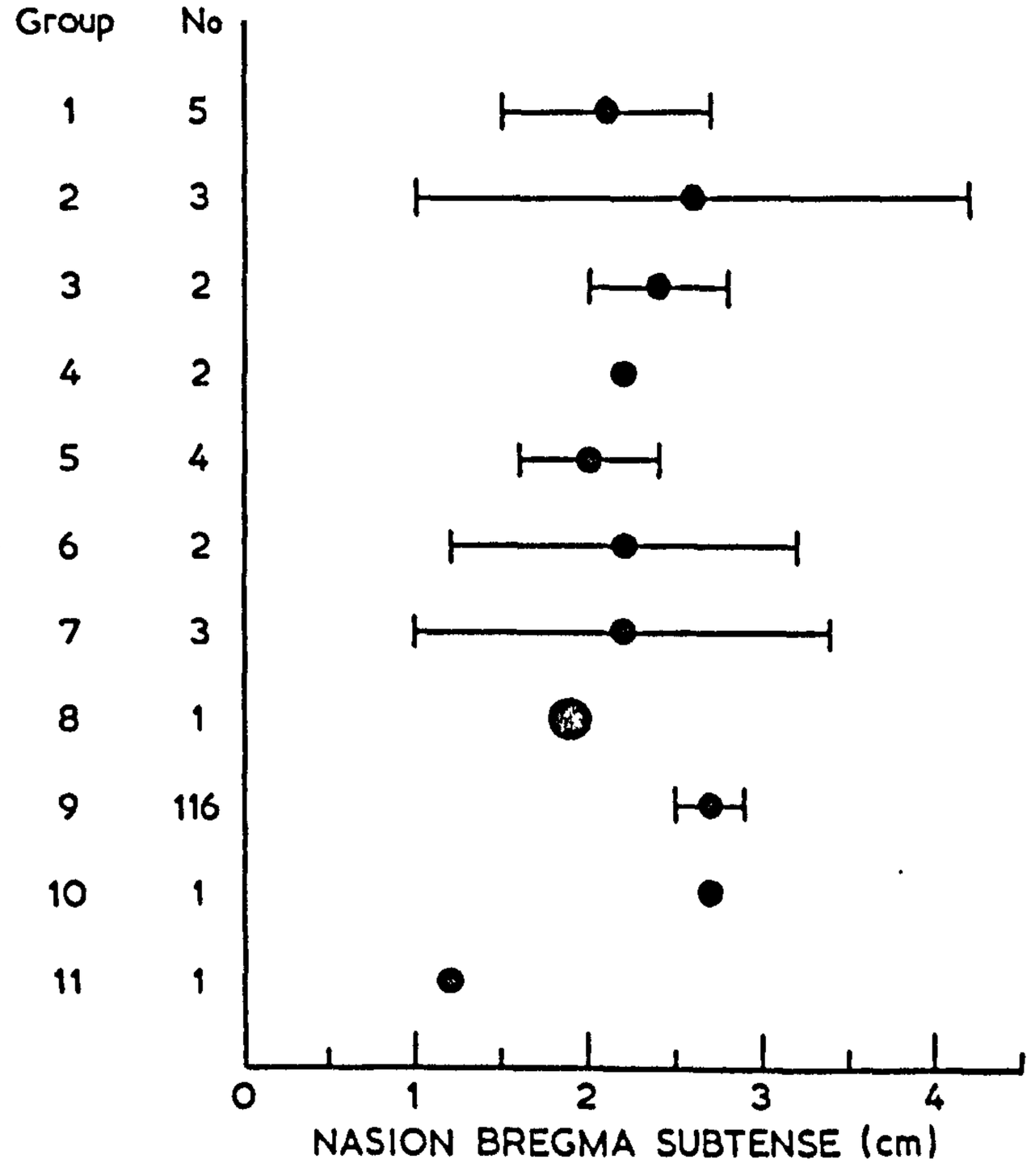
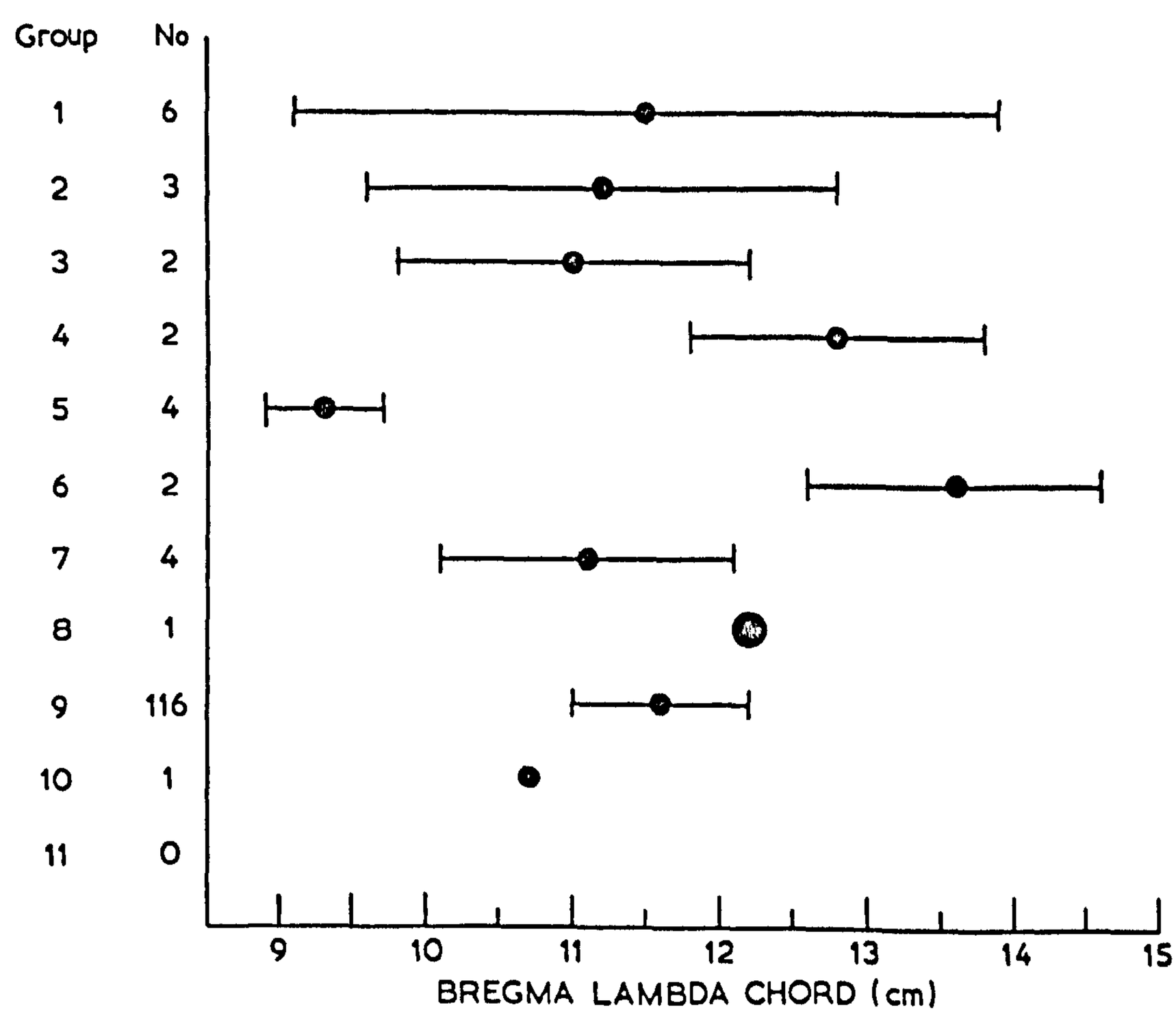


FIGURE 14

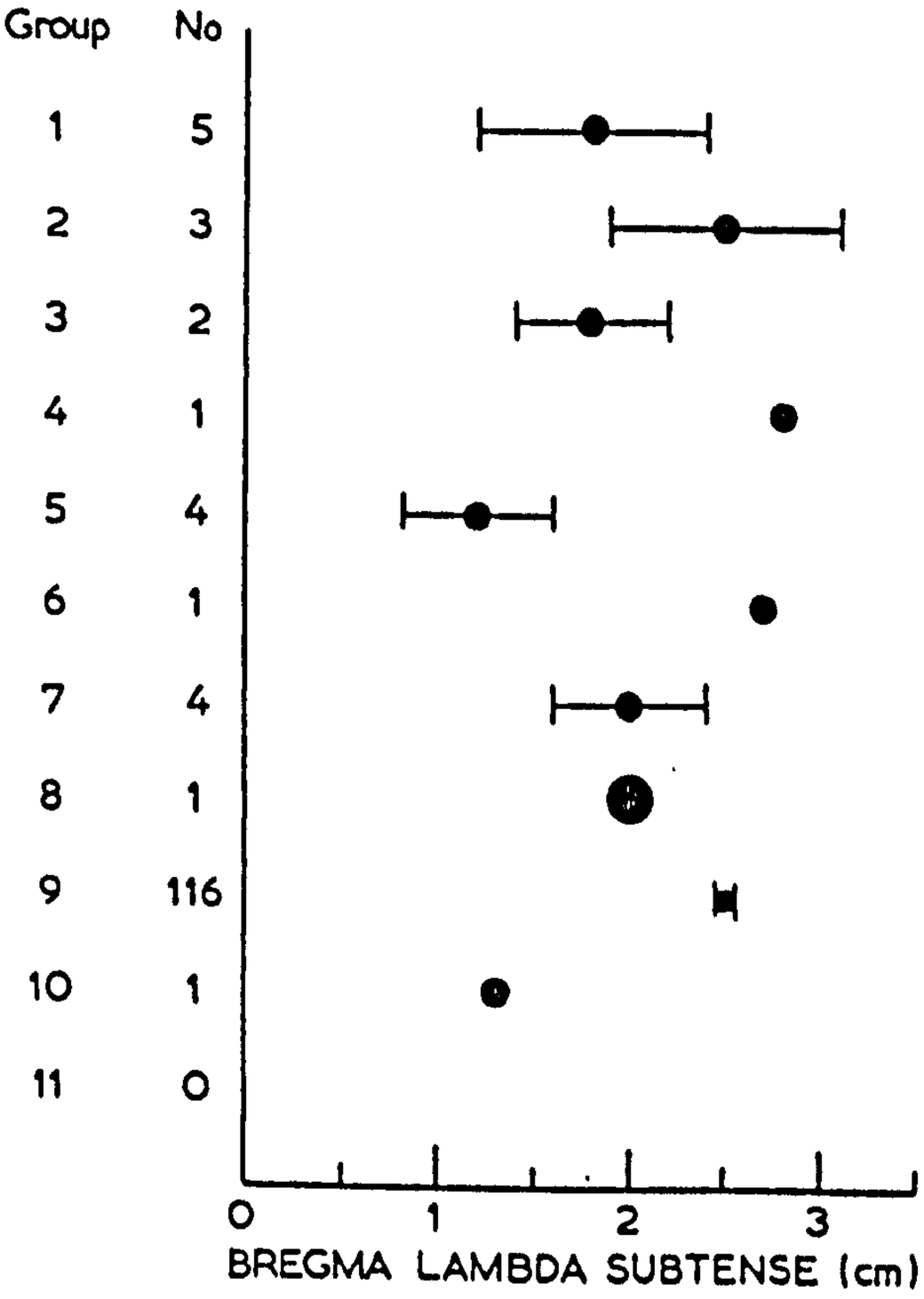


the sub-Saharan modern and the Far East/Australia and the Middle East later Upper Pleistocene groups. The Pekin *Homo erectus* group has a mean position well outside the range of the sub-Saharan modern group.

(xii) The bregma lambda subtense: Figure 15 shows the means and the ranges within two standard deviations (on either side of the means) of the bregma lambda subtense for the hominid groups. The group ranges are small. The lowest range is shown by the sub-Saharan modern group (1). Laetoli Hominid 18 has identical bregma-lambda subtense measurement with the European early Upper Pleistocene group. Similarly, the mean position of the sub-Saharan early Upper Pleistocene group is similar to that of the Middle East early Upper Pleistocene group. The sub-Saharan modern group has an identical mean position to that of the sub-Saharan later Upper Pleistocene group while the Pekin *Homo erectus*, the sub-Saharan early Upper Pleistocene, the Middle East early Upper Pleistocene, the European early Upper Pleistocene the Laetoli Hominid 18 and the North African Upper Pleistocene groups lie well outside the range of the sub-Saharan modern group.

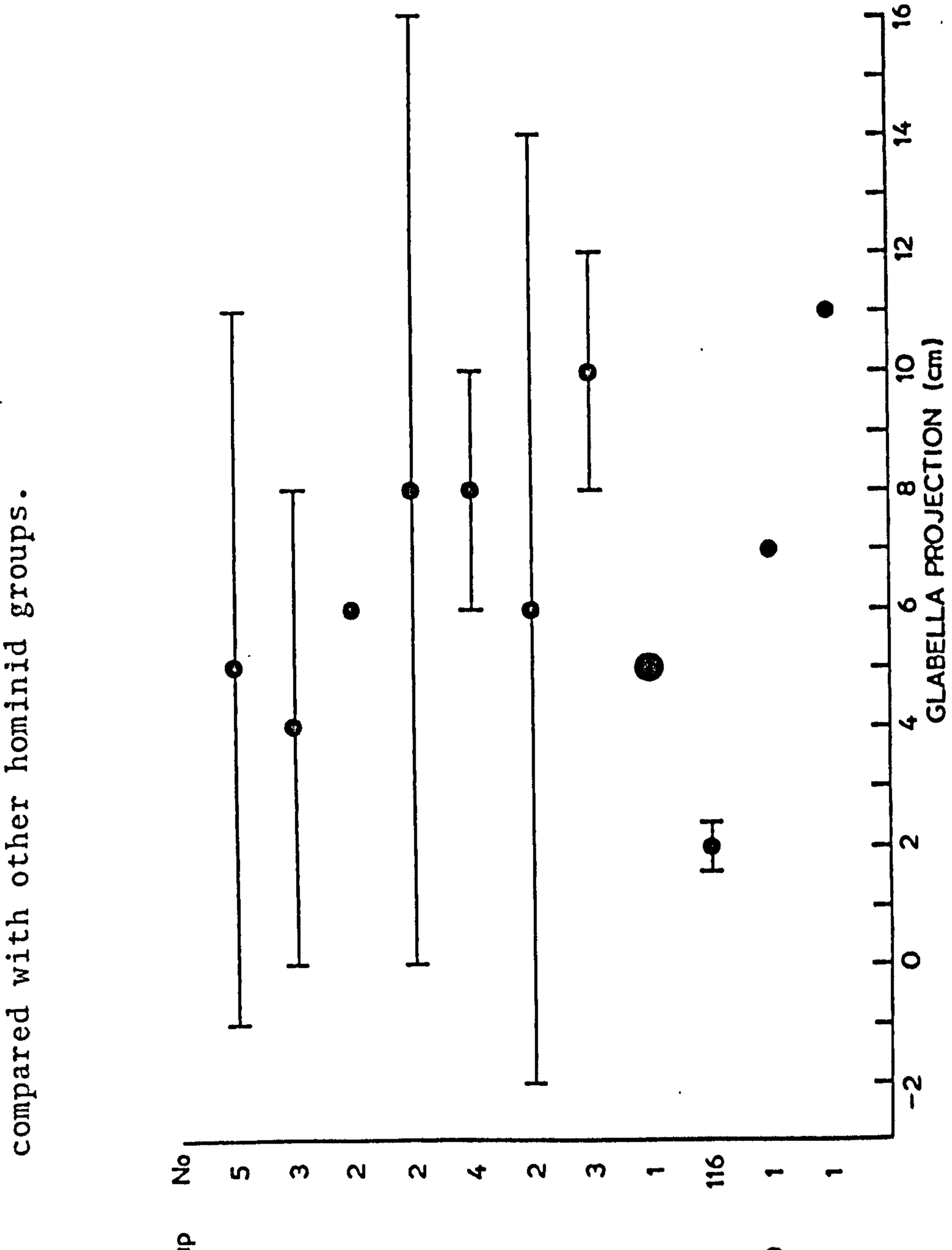
(xiii) The glabella projection: Figure 16 shows the means and the ranges within two standard deviations (on either side of the means) of the glabella projection measurement. The groups show high ranges especially those of the Middle East later Upper Pleistocene (90), the Far

FIGURE 15



Plot of the bregma lambda subtense: Laetoli Hominid 18 cranium compared with other hominid groups.

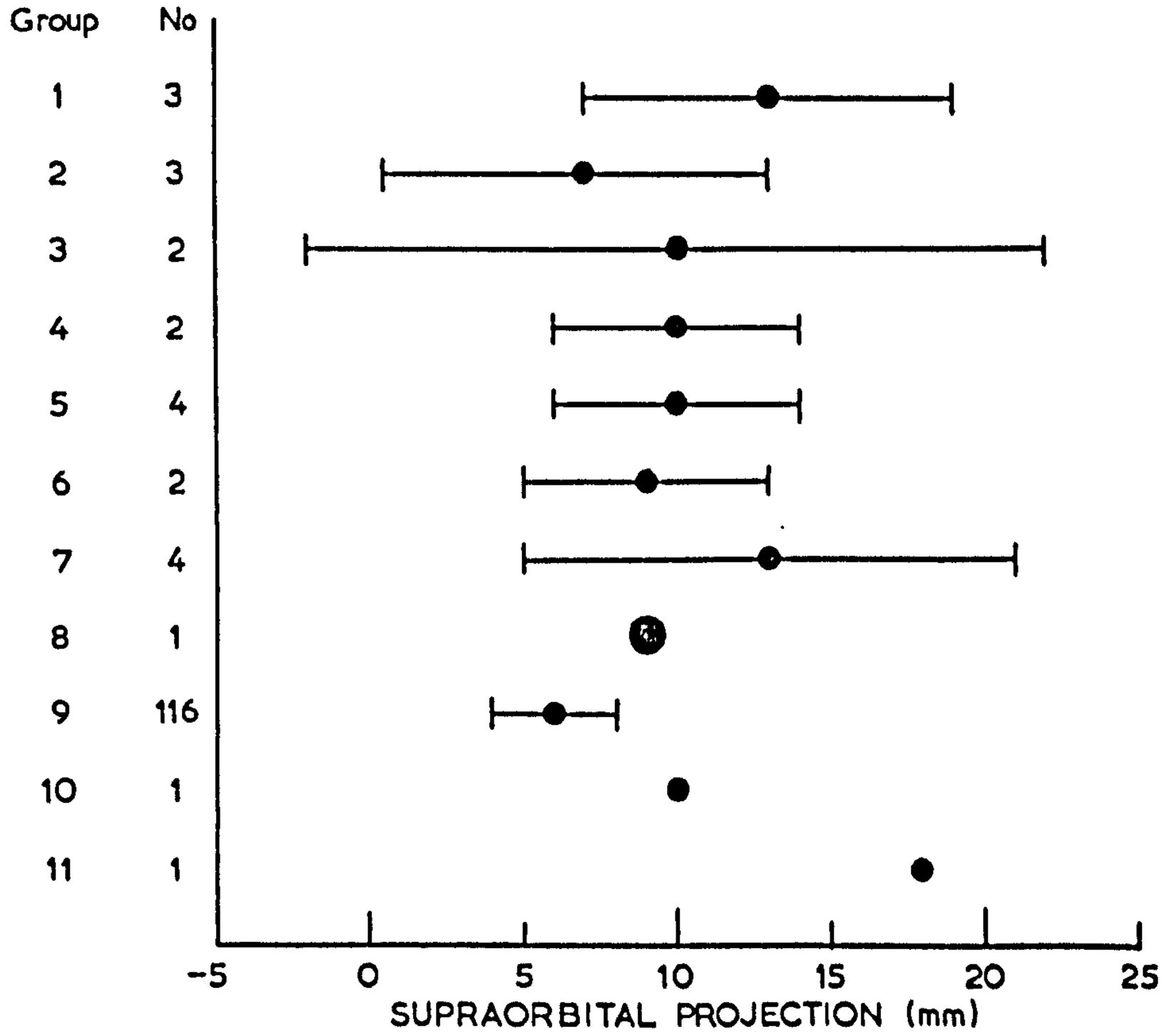
FIGURE 16: Plot of the glabella projection: Laetoli Hominid 18 cranium compared with other hominid groups.



East/Australia Upper Pleistocene, the sub-Saharan later Upper Pleistocene. The sub-Saharan modern group shows the lowest range of (1.6). Laetoli Hominid 18 lies well outside the range of the sub-Saharan modern group but is within the ranges of the Far East/Australia Upper Pleistocene, the Middle East later Upper Pleistocene, the sub-Saharan early and later Upper Pleistocene groups. The Pekin *Homo erectus*, the European early Upper Pleistocene, the North African Upper Pleistocene and the sub-Saharan *Homo erectus* groups all lie well outside the range of the sub-Saharan group.

(xiv) The supraorbital projection: Figure 17 shows the means and the ranges within two standard deviations (on either side of the means) for the supraorbital projection. Unlike the glabella projection, the groups show reduced ranges. The sub-Saharan modern group shows the least range of (6.5). Laetoli Hominid 18 has identical supraorbital projection to the Far East/ Australia Upper Pleistocene group and lies slightly outside the range of the sub-Saharan modern group. The mean positions for the European early Upper Pleistocene the Pekin *Homo erectus*, the Middle East later Upper Pleistocene and the Middle East early Upper Pleistocene are similar.

FIGURE 17



Plot of the supraorbital projection: Laetoli Hominid 18 cranium compared with other hominid groups.

Summary of the Univariate Analyses

The overall univariate analyses further support the view shown by the non-metrical comparisons that Laetoli Hominid 18 cranium shows a mixture of both archaic and modern features. Considering the overall cranial length, Laetoli Hominid 18 has a very long cranium as compared to the sub-Saharan modern group. Other hominid fossil groups with shorter crania compared to the Laetoli Hominid 18 include, the Middle East later Upper Pleistocene and the Pekin *Homo erectus*. The overall cranial length of the Laetoli Hominid 18 is identical to that of the sub-Saharan *Homo erectus* group and falls within the ranges of two standard deviations of the sub-Saharan early and later Upper Pleistocene, the Middle East early Upper Pleistocene, the Far East/Australia Upper Pleistocene and the European early Upper Pleistocene groups.

The cranial width measurements of the Laetoli Hominid 18 places it closer to the sub-Saharan modern group. Thus, the maximum cranial breadth of the Laetoli Hominid 18 lies slightly outside the range of two standard deviations of the sub-Saharan modern group. The specimens however, lies within the ranges of two standard deviations of the sub-Saharan later Upper Pleistocene, the Middle East early and later Upper Pleistocene and the Pekin *Homo erectus* groups. The European early Upper Pleistocene, the North African Upper Pleistocene and the sub-Saharan *Homo erectus* groups show much higher maximum cranial breadth measurements compared to both Laetoli Hominid 18

and to the sub-Saharan modern group. The maximum frontal breadth together with the minimum cranial breadth measurements of the Laetoli Hominid 18 fall within the range of two standard deviations of the sub-Saharan modern group. Thus, in the maximum frontal breadth, Laetoli Hominid 18 is identical to the European early Upper Pleistocene group. Other hominid groups with maximum frontal breadth measurement falling within two standard deviations of the sub-Saharan modern group include, the sub-Saharan early and later Upper Pleistocene, the Middle East later Upper Pleistocene, the Pekin *Homo erectus* and the sub-Saharan *Homo erectus*. The Middle East early Upper Pleistocene, the Far East/Australia Upper Pleistocene and the North African Upper Pleistocene groups have their maximum frontal breadths well outside the range of the sub-Saharan modern group. The minimum cranial breadth of the Laetoli Hominid 18 is almost identical to that of the sub-Saharan modern group and falls within the ranges of two standard deviations of the sub-Saharan early and later Upper Pleistocene, the Middle East early Upper Pleistocene and the Far East/Australia Upper Pleistocene groups. The Pekin *Homo erectus* and the sub-Saharan *Homo erectus* groups as a whole show the least measurements of the minimum cranial breadths.

In general terms, the maximum cranial breadth, the minimum cranial breadth and the maximum frontal breadth measurements of the Laetoli Hominid 18 cranium correspond to those of the sub-Saharan modern group.

The other fossil hominid groups with almost similar cranial breadth measurements to the Laetoli Hominid 18 include the sub-Saharan early Upper Pleistocene, the Middle East later Upper Pleistocene and the sub-Saharan later Upper Pleistocene groups. The Pekin *Homo erectus* and the sub-Saharan *Homo erectus* groups show small cranial breadths compared to the rest of the groups.

The bi-frontal and the interorbital breadths of the Laetoli Hominid 18 places it again closer to the sub-Saharan modern group. The fossil hominid groups with almost similar bi-frontal and interorbital breadth measurements to the Laetoli Hominid 18 include, the sub-Saharan later Upper Pleistocene and the Middle East later Upper Pleistocene. The sub-Saharan *Homo erectus* together with the Pekin *Homo erectus* groups show much wider bi-frontal and interorbital breadth measurements. The European early Upper Pleistocene, the Middle East early Upper Pleistocene and the sub-Saharan early Upper Pleistocene have their interorbital and bi-frontal breadth measurements intermediate between the sub-Saharan modern and the *Homo erectus* groups.

In the biauricular and biasterionic breadths, Laetoli Hominid 18 lies well outside the ranges of two standard deviations of the sub-Saharan modern group. However, the specimen lies within the ranges of two standard deviations of the sub-Saharan early and later Upper Pleistocene and the Middle East later Upper Pleistocene

groups. The Middle East early Upper Pleistocene, the Pekin *Homo erectus*, the European early Upper Pleistocene and the sub-Saharan *Homo erectus* groups show much wider biauricular breadth measurements compared to both Laetoli Hominid 18 and the sub-Saharan modern group.

The length of the frontal bone of the Laetoli Hominid 18 lies slightly outside the range of two standard deviations of the sub-Saharan modern group, but is identical to that of the North African Upper Pleistocene group. Other fossil groups with similar frontal bone length to Laetoli Hominid 18 include, the European early Upper Pleistocene, the Far East/Australia Upper Pleistocene, the Middle East early Upper Pleistocene, the sub-Saharan early and later Upper Pleistocene. The nasion bregma subtense measurement of the Laetoli Hominid 18 places it well outside the range of the sub-Saharan modern group. In the nasion bregma subtense measurement, Laetoli Hominid 18 lies within the ranges of the European early Upper Pleistocene, the Far East/Australia Upper Pleistocene, the Pekin *Homo erectus*, the sub-Saharan early and later Upper Pleistocene groups. Thus, the general morphology of the frontal bone of the Laetoli Hominid 18 as a whole resembles those of the sub-Saharan early and later Upper Pleistocene, the Far East/Australia Upper Pleistocene, the Pekin *Homo erectus* and the European early Upper Pleistocene groups.

The parietal length of the Laetoli Hominid 18 cranium places it closer to the sub-Saharan modern group

and falls within the ranges of the Middle East later Upper Pleistocene, sub-Saharan early and later Upper Pleistocene groups. The Pekin *Homo erectus* and to a lesser extent, the Middle East early Upper Pleistocene together with the European early Upper Pleistocene groups have generally shorter parietals compared to the Laetoli Hominid 18. The degree of parietal bone flatness of the Laetoli Hominid 18 is almost identical to that of the European early Upper Pleistocene group. Other fossil groups with almost similar degrees of parietal flattening to Laetoli Hominid 18 include, the sub-Saharan early and later Upper Pleistocene, the Middle East early Upper Pleistocene and the European early Upper Pleistocene. Thus, as far as the morphology of the parietal bone is concerned, Laetoli Hominid 18 shows similarities to the sub-Saharan early and later Upper Pleistocene groups and to a lesser extent to the Middle East early Upper Pleistocene and the European early Upper Pleistocene groups. The Pekin *Homo erectus* groups show relatively short and flattened parietal bones compared to the rest of the other groups.

The glabella projection together with the supra-orbital projection for the Laetoli Hominid 18 places it well outside the range of the sub-Saharan modern group. In the glabella projection Laetoli Hominid 18 lies within the ranges of the Far East/Australia, Middle East later Upper Pleistocene, and sub-Saharan early and later Upper Pleistocene groups. The Pekin *Homo erectus*, the

European Upper Pleistocene, the North African Upper Pleistocene and the sub-Saharan *Homo erectus* groups all show large glabella projections compared to either Laetoli Hominid 18 or to the sub-Saharan modern groups. The supraorbital projection of the Laetoli Hominid 18 lies within the ranges of the sub-Saharan early and later Upper Pleistocene, the Middle East early and later Upper Pleistocene, Pekin *Homo erectus*, Far East/Australia Upper Pleistocene and the European early Upper Pleistocene groups.

From the univariate analyses, it can be concluded that Laetoli Hominid 18 cranium exhibits both archaic and modern features. The archaic features of the cranium are revealed by the measurements of the glabello-occipital length, the biauricular and biasterionic breadths, the frontal chord and subtense, the parietal chord and subtense, the glabella and the supraorbital projections. The cranium shows modern features in the maximum and minimum cranial breadths, the maximum frontal breadth and in the interorbital and bi-frontal breadth measurements. The fossil hominid group showing the most similar features to the Laetoli Hominid 18 is the sub-Saharan early Upper Pleistocene and is followed by the sub-Saharan later Upper Pleistocene, the Middle East later Upper Pleistocene, the Far East/Australia Upper Pleistocene and the European early Upper Pleistocene groups.

(b) Results of the Bivariate Analyses

The bivariate analyses were mainly done on the frontal and parietal bones, since these are better preserved and almost complete in the Laetoli Hominid 18 cranium. Seven variables were used in these analyses and consisted of the glabello-occipital length (variable 4), the nasion bregma chord (8), the nasion bregma subtense (9), the bregma lamda chord (11), the bregma lambda subtense (12), the maximum cranial breadth (6) and the minimum cranial breadth (19).

The materials were ungrouped for these analyses to enable the inclusion of as many specimens as possible and to show their relationships to each other. The same hominid cranial materials as listed in Table 1 were used in these analyses.

The results of the bivariate analyses are presented in the distribution plots (Figs. 18-20) and consists of: (1) frontal subtense/chord plotted against frontal chord/ glabello-occipital length (as a measure of length and profile of the frontal bone in relation to the overall length of the cranium, (2) the second analysis shows the Minimum cranial breadth/Maximum cranial breadth plotted against frontal chord/glabello-occipital length (as a measure of length and width of the frontal bone in relation to the overall cranial length and breadth), (3) the third analysis shows the parietal subtense/chord plotted against parietal chord/glabello-occipital length

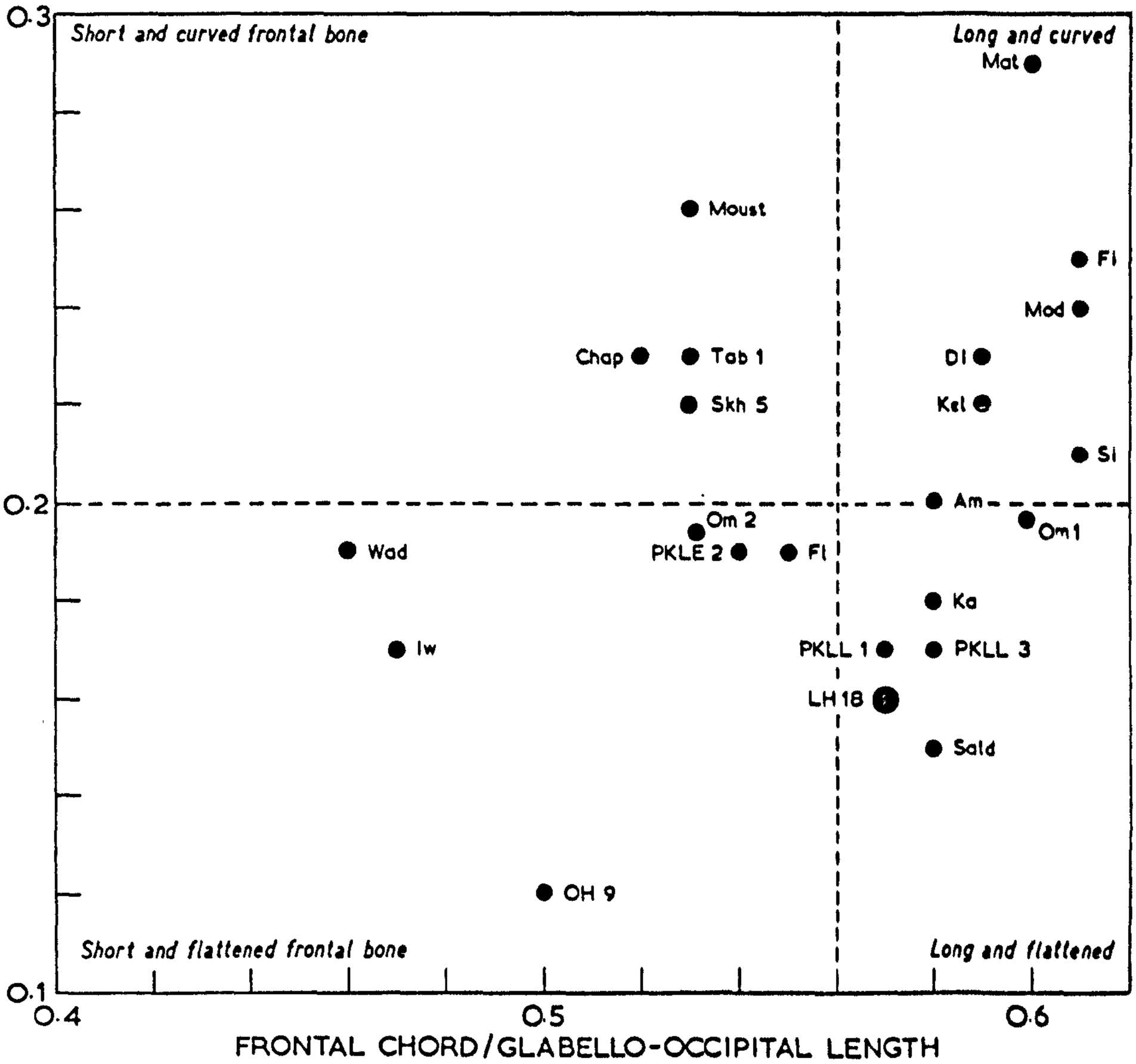
(as a measure of length and profile of the parietal bone in relation to the overall length of the cranium).

For convenience, the bivariate plots have been divided up into four quadrants by taking the mean values of the considered variables for the whole sample as reference points.

(i) The frontal bone: Frontal subtense/chord plotted against frontal chord/glabello-occipital length (Fig. 18). This bivariate distribution plot illustrates the differences in the pattern of the frontal bone in different hominids varying from *Homo erectus* to anatomically modern *Homo sapiens* crania. The Laetoli Hominid 18 is well separated from the sub-Saharan modern crania and lies within the lower right hand quadrant. Close to the Laetoli Hominid 18 are the Pekin Locus L 1 and 3, the Kabwe and the Saldanha specimens. Also within the same quadrant but separated from the Laetoli Hominid 18 is the Omo I specimen. All of the above specimens appear to have identical frontal bone length and degree of frontal flatness. In other words, the above specimens are characterised by long and flattened frontal bones.

The sub-Saharan modern crania together with the Fish Hoek, Djebel Irhoud and Keilor I are close to each other and occupy the upper right hand quadrant. Within the same quadrant are the Matjes River and the Singa crania well separated from the sub-Saharan Modern crania. All

FIGURE 18



Plot of the (i) Frontal subtense/Chord and

(ii) Frontal chord/Glabello-occipital length:

Laetoli Hominid 18 cranium compared with other hominid crania.

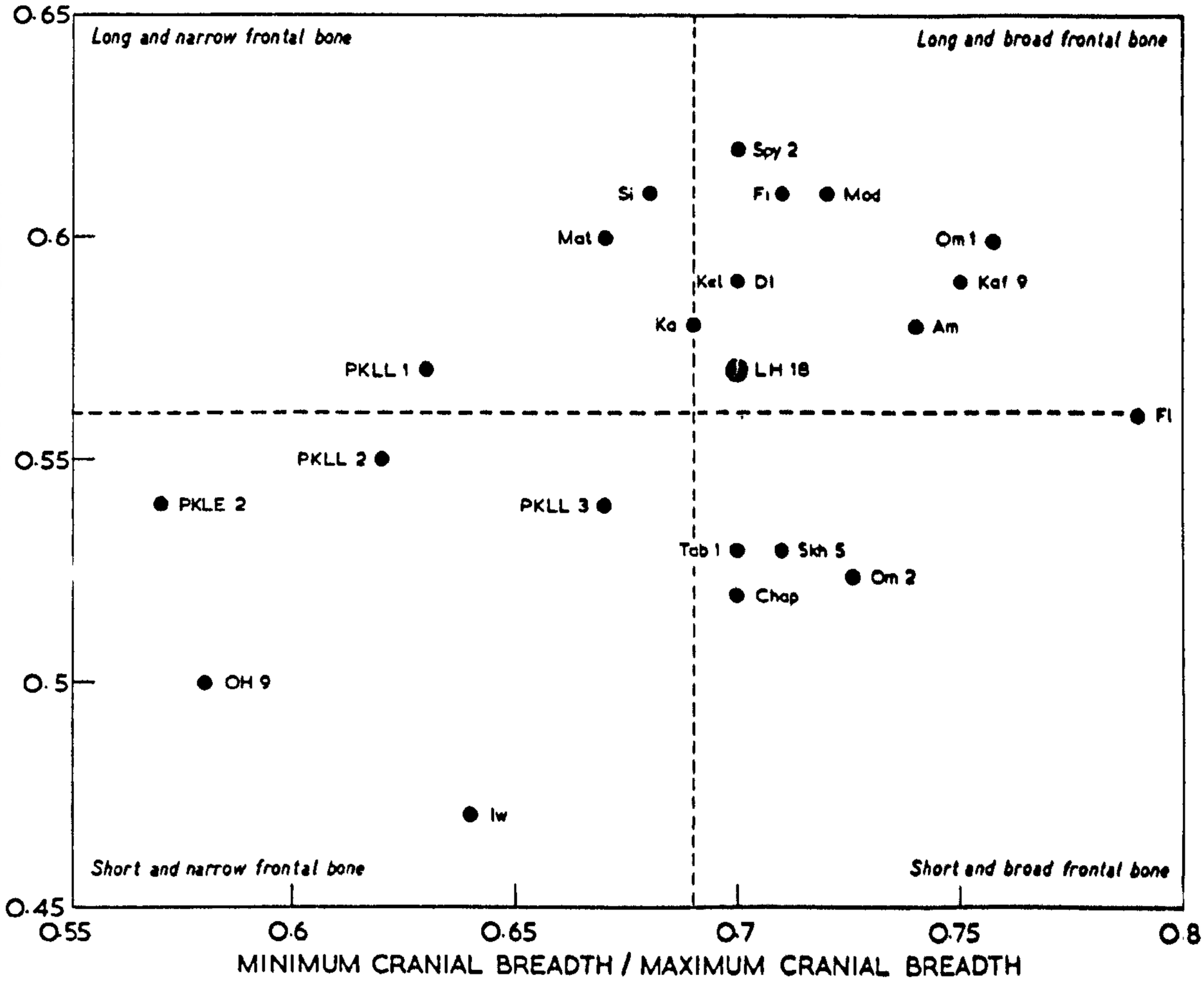
of the specimens in the upper right hand quadrant, unlike the Laetoli Hominid 18, are characterised by long and curved frontal bones.

The Olduvai Hominid 9 as well as a Wadjak I and Iwo Eleru specimens are well separated from the Laetoli Hominid 18 and occupy the lower left hand quadrant. Within the same quadrant and lying close to each other are the Omo 2, the Pekin Locus E 2 and the Florisbad specimens. The specimens in the lower left hand quadrant, unlike the Laetoli Hominid 18, have short and flattened frontal bones.

The La Chapelle-aux-Saints, Tabūn I and Skhūl 5 are close to each other and occupy the upper left hand quadrant. The Le Moustier specimen occupies similar quadrant but is well separated from the La Chapelle-aux-Saints and Tabūn I specimens. The above specimens differ from the Laetoli Hominid 18 cranium in having short and curved frontal bones.

(ii) Frontal chord/glabello-occipital length plotted against minimum cranial breadth/maximum cranial breadth (Fig. 19). This distribution plot like that of (Fig. 18), illustrates the differences in the shape and size of the frontal bone in different hominids varying from *Homo erectus* to anatomically modern *Homo sapiens* crania. The Laetoli Hominid 18 occupies the upper right hand quadrant and is close to the Kabwe, Keilor I and the Djebel Irhoud specimens. Occupying the same quadrant but

FIGURE 19



Plot of the (i) Frontal chord/Glabello-occipital length and (ii) Minimum cranial breadth/Maximum cranial breadth: Laetoli Hominid 18 cranium compared with other hominid crania.

well separated from the Laetoli Hominid 18 are the Omo I, the Kafzeh 9 and the Amud I specimens lying close to each other. The above specimens appear to be characterized by long and widened frontal bones.

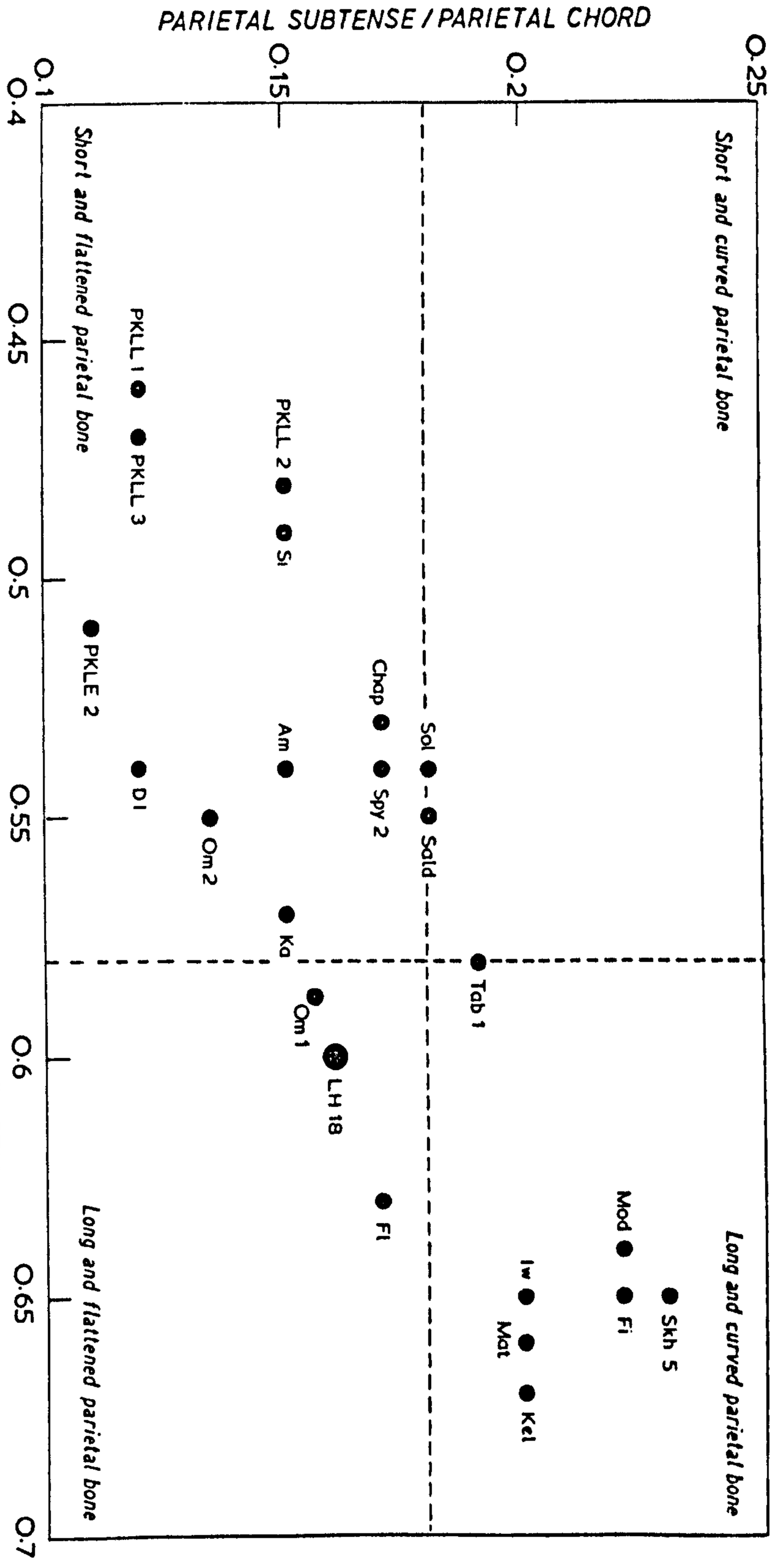
Occupying the lower right hand quadrant and lying close to each other are the Tabūn I, Skhūl 5, La Chapelle-aux-Saints and the Omo 2 specimens. These specimens unlike the Laetoli Hominid 18 appear to be characterized by shorter and wider frontal bones.

The Olduvai Hominid 9, together with the Iwo Eleru are again well separated from the rest of the specimens and occupy the lower left hand quadrant as are the Pekin Locus E 2, Pekin Locus L 2 and 3 specimens. Unlike the Laetoli Hominid 18, the above specimens are characterized by short and narrow frontal bones.

Occupying the upper left hand quadrant are the Singa and the Matjes River specimens lying close to each other. The Pekin Locus L 1 specimen also occupies the same quadrant but is more close to the other Pekin *Homo erectus* crania. The Singa, Matjes River and the Pekin Locus L 1 specimens differ from the Laetoli Hominid 18 by having long and narrow frontal bones.

(iii) The Parietal bone: Parietal subtense/chord plotted against parietal chord/glabello-occipital length (Fig. 20). This bivariate distribution plot illustrates the differences in the parietal bone size and

FIGURE 20: Plot of the (i) Parietal subtense/Chord and (ii) Parietal chord/Glabello-occipital length: Laetoli Hominid 18 cranium compared with other fossil hominid crania.



shape in different hominids varying from *Homo erectus* to anatomically modern *Homo sapiens* crania. The Laetoli Hominid 18 is close to the Omo I and both occupy the lower right hand quadrant. Occupying the same quadrant but separated from the Laetoli Hominid 18 is the Florisbad specimen. The specimens in this quadrant appear to be characterized by long and flattened parietal bones.

The sub-Saharan modern, Skhūl 5 and Fish Hoek crania are close to each other as are the Iwo Eleru, Matjes River and the Keilor I specimens. All of these specimens, unlike Laetoli Hominid 18, are characterized by long and curved parietal bones.

The Pekin Locus L 1, 2 and 3, together with the Singa specimens are close to each other as are the La Chapelle-aux-Saints, Spy 2, Solo I and the Saldanha specimens. The Kabwe, Omo 2, Djebel Irhoud and the Pekin Locus E 2 are also close to each other. All of the above specimens lie within the lower left hand quadrant and differ from the Laetoli Hominid 18 by having short and flattened parietal bones.

The bivariate analyses as a whole, illustrate well the differences in the patterns of the frontal and parietal bones in the different hominid specimens considered. Thus, the Laetoli Hominid 18 cranium is characterised by long, flattened and widened frontal bone and with long and flattened parietal bone. The above features of the Laetoli Hominid 18 seem to separate it from the sub-

Saharan modern, the Fish Hoek and the Keilor specimens on the one hand and the Pekin *Homo erectus*, La Chapelle-aux-Saints, the Tabūn I and the Olduvai Hominid 9 on the other. The sub-Saharan modern, the Fish Hoek and the Keilor I specimens, unlike the Laetoli Hominid 18, are characterized by long, curved and widened frontals and with long, curved parietal bones.

The Pekin *Homo erectus* crania as a whole differ from the Laetoli Hominid 18 in having short, flat and narrow frontal bones and with short and flattened parietal bones.

The Saldanha and the Kabwe specimens show similar frontal and parietal bone morphology to each other and are characterised by long and flat frontal bones and with short and flattened parietal bones. The two specimens slightly differ from the Laetoli Hominid 18 in the size of the parietal bones, whereby the latter specimen has slightly longer parietal bones.

The Omo I and Omo 2 specimens show differences in their frontal and parietal bones morphology. Thus, the Omo 2 unlike Omo I has short flat and broad frontal bone and with short and flattened parietal bones while Omo I is characterized by long, flattened and broad frontal bones and with long flattened parietal bones. The frontal and parietal morphology of the Omo I resembles those of the Laetoli Hominid 18 cranium. The Omo 2 specimen resembles the Kabwe and Saldanha specimens in their parietal

bone morphology, while its frontal bone morphology resembles those of the La Chapelle-aux-Saints, Tabūn I and Skhūl 5 specimens.

The Singa specimen differs from the Laetoli Hominid 18 in having long, curved and narrow frontal bones and with short and flattened parietals just like Kabwe and Saldanha and Omo 2 specimens. The La Chapelle-aux-Saints specimen is characterized by short, curved and broad frontal bone almost similar to Tabūn I and Skhūl 5, while its parietal bones are short and flattened as in the Kabwe, Omo 2, Saldanha, Djebel Irhoud, Amud I, Singa, Spy 2 and the Pekin *Homo erectus* crania.

In conclusion, it can be said that as far as the frontal and parietal bones are concerned, the Laetoli Hominid 18 cranium closely resembles the Kabwe, Saldanha and Omo I specimens and differs greatly from the sub-Saharan modern, the Pekin *Homo erectus*, Olduvai Hominid 9 and the La Chapelle-aux-Saints crania.

(c) <u>Results of the Multivariate Statistical Analyses</u>

A total of 27 variables as used in the univariate and bivariate metrical analyses (Table 4) were subjected to multivariate statistical analyses. Due to the number of missing values of some of the comparative materials, it was only possible to use a maximum of ten of these variables. The usable variables included, the nasion

bregma arc (variable 1), bregma lambda arc (2), glabello-occipital length (4), maximum cranial breadth (6), maximum frontal breadth (7), nasion bregma chord (8), bregma lambda chord (11), glabella projection (16), supraorbital projection (17) and the interorbital breadth (18). The overall means, minima, maxima and standard deviations for each of the variables for the separate groups are shown in Table 11.

Only 10 groups of the hominid crania out of the original 11 as shown in Table 1 were used in the multivariate analyses and consisted of (1) the sub-Saharan early Upper Pleistocene, (2) the sub-Saharan later Upper Pleistocene, (3) the Middle East early Upper Pleistocene, (4) the Middle East later Upper Pleistocene, (5) the Pekin *Homo erectus*, (6) the Far East/Australia Upper Pleistocene, (7) the European early Upper Pleistocene, (8) the Laetoli Hominid 18 cranium, (9) the sub-Saharan modern and (10) the North African Upper Pleistocene. Due to too many missing values, group (11) was excluded from the multivariate analyses.

The canonical variate analysis derived six variates accounting for the variance as follows:

Axis	Latent roots	% Variance
I	48.89	78.50
II	7.51	12.05
III	4.22	6.78
IV	0.94	1.51
V	0.54	0.87
VI	0.18	0.28

TABLE 12. Coordinates of group means on canonical I-VI for the modern and fossil hominid groups employed in the multivariate analyses.

Group		Axis I	II	III	IV	V	VI
Sub-Saharan early Upper Pleistocene	(1)	-1.384	-1.113	2.157	0.736	-0.134	
Sub-Saharan later Upper Pleistocene	(2)	-8.456	1.607	-2.037	0.657	0.859	-0.073
Middle East early Upper Pleistocene	(3)	2.697	-1.768	-1.528	0.502	-0.331	1.001
Middle East later Upper Pleistocene	(4)	-6.437	2.653	2.283	-1.810	0.089	0.373
Pekin *Homo erectus*	(5)	9.786	3.068	-0.161	0.108	0.092	-0.100
Far East/Australia Upper Pleistocene	(6)	-4.671	0.688	-2.132	-0.299	-1.646	-0.331
European early Upper Pleistocene	(7)	2.837	-3.390	-0.857	-0.901	0.408	0.216
Laetoli Hominid 18 cranium	(8)	1.744	5.015	-2.076	0.190	-1.277	-3.290
Sub-Saharan modern	(9)	-4.752	4.688	-0.037	0.064	-0.920	-0.748
North African Upper Pleistocene	(10)	1.846	-3.197	-3.540	0.824	0.585	0.354

TABLE 13. Individual fossil hominids and modern crania with their corresponding coordinates and canonical axes I-VI

Material	Axis I	II	III	IV	V	VI
1. Laetoli Hominid 18	1.744	5.015	-2.076	0.190	-1.277	-3.290
2. Kabwe	-0.632	-0.637	1.240	-0.229	0.115	-0.797
3. Omo 1	-1.567	-2.016	1.538	1.448	-0.504	0.173
4. Omo 2	-2.207	-1.744	3.189	1.101	0.399	1.070
5. Singa	-0.759	-2.278	1.680	2.471	1.203	0.522
6. Florisbad	-0.988	-1.994	3.000	0.472	-2.068	0.305
7. Saldanha	-1.004	0.193	2.764	0.038	0.302	-1.194
8. Iwo Eleru	-7.764	1.731	-2.339	1.851	0.207	-0.625
9. Fish Hoek	-7.884	0.366	-0.552	0.701	1.361	-0.242
10. Matjes River	-9.145	1.825	-2.484	0.792	0.753	0.991
11. Tabūn 1	3.011	-1.965	-1.845	-0.235	-0.652	3.087
12. Amud 1	2.766	-2.169	-0.721	1.219	-0.179	-0.857
13. Skhūl 5	-5.184	1.657	1.518	-2.857	0.996	0.889
14. Kafzeh 9	-7.306	3.051	3.539	-0.783	0.988	0.084
15. Wadjak 1	-5.068	0.225	-2.132	-1.058	-2.123	-1.003
16. Keilor 1	-3.892	0.552	-1.642	0.441	-1.338	0.568
17. PKLE 2	8.191	3.522	1.186	0.511	1.482	0.584
18. PKLL 1	9.098	2.216	-1.692	0.453	-1.339	0.317
19. PKLL 2	10.802	3.315	-0.693	0.023	0.676	0.258
20. PKLL 3	11.819	2.023	1.534	0.426	-0.790	0.046
21. La Chapelle	3.350	-4.754	-0.594	-0.526	0.375	-0.173
22. La Ferrassie	1.786	-5.267	-0.832	-1.545	0.862	-0.941
23. Spy 1	3.496	-2.234	-0.028	-1.362	-0.820	0.381
24. Spy 2	3.484	-2.503	-0.993	-0.211	0.877	0.327
25. Djebel Irhoud	1.846	-3.197	-3.540	0.824	0.585	0.354
26. Sub-Saharan modern	-4.752	4.688	-0.037	0.064	-0.920	-0.748

The first three variates encompass 97% of the total variability. The group means of each canonical variate are listed in Table 12 whilst, the co-ordinates of the individual specimens on the canonical plots are listed in Table 13. Figures (21-25) show the plots of the fossil and modern crania groups on canonical Axes I and II, I and III, I and IV, I and V and I and VI.

The plot of Axes I and II (Fig. 21), provides a good separation between the groups. Laetoli Hominid 18 cranium is well separated from the rest of the groups occupying the upper right hand quadrant between the sub-Saharan modern and Pekin *Homo erectus* groups. Also, well separated is the Pekin *Homo erectus* group occupying the extreme limits of the upper right hand quadrant. The sub-Saharan later Upper Pleistocene, Middle East later Upper Pleistocene, sub-Saharan modern and Far East/Australia Upper Pleistocene groups form an overlapping spread within the upper left hand quadrant, while the Middle East and European early Upper Pleistocene groups, together with the North African Upper Pleistocene group form a similar overlapping spread within the lower right quadrant. Between the Far East/Australia Upper Pleistocene and the Middle East early Upper Pleistocene groups, occupying almost the centre of the figure, is the sub-Saharan early Upper Pleistocene group.

Examination of Axis I, reveals a continuous spread along the axis with a maximum separation of (18.3) units

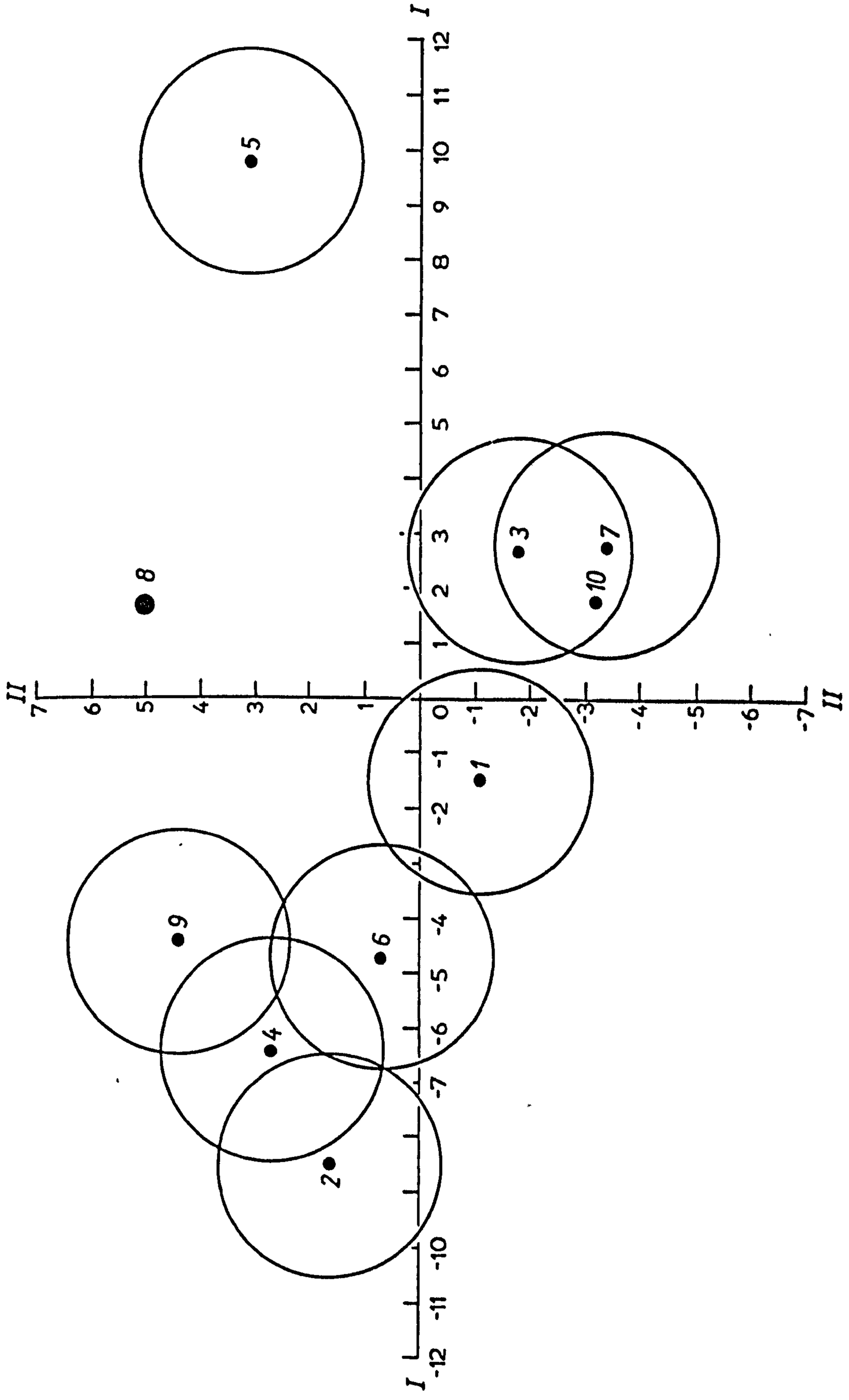


FIGURE 21: Plot of the canonical variate analysis, Axis I and II:
Laetoli Hominid 18 cranium compared with other hominid groups.

between Pekin *Homo erectus* group at the positive limit and sub-Saharan later Upper Pleistocene group at the negative limit. Closer to Laetoli Hominid 18 along Axis I, are the North African Upper Pleistocene, Middle East, European and sub-Saharan early Upper Pleistocene groups separated by (0.1), (1.0), (1.1) and (3.3) units respectively. The furthest group from Laetoli Hominid 18 is the sub-Saharan later Upper Pleistocene, separated by (11.2) units and is followed by Middle East later Upper Pleistocene, Pekin *Homo erectus* each separated by (8.1) units, Far East/Australia Upper Pleistocene and sub-Saharan Modern groups each separated by (6.5) units. Thus, Axis I places Laetoli Hominid 18 closer to the archaic *Homo sapiens* groups and significantly separates it from the Pekin *Homo erectus*, sub-Saharan modern and later Upper Pleistocene groups.

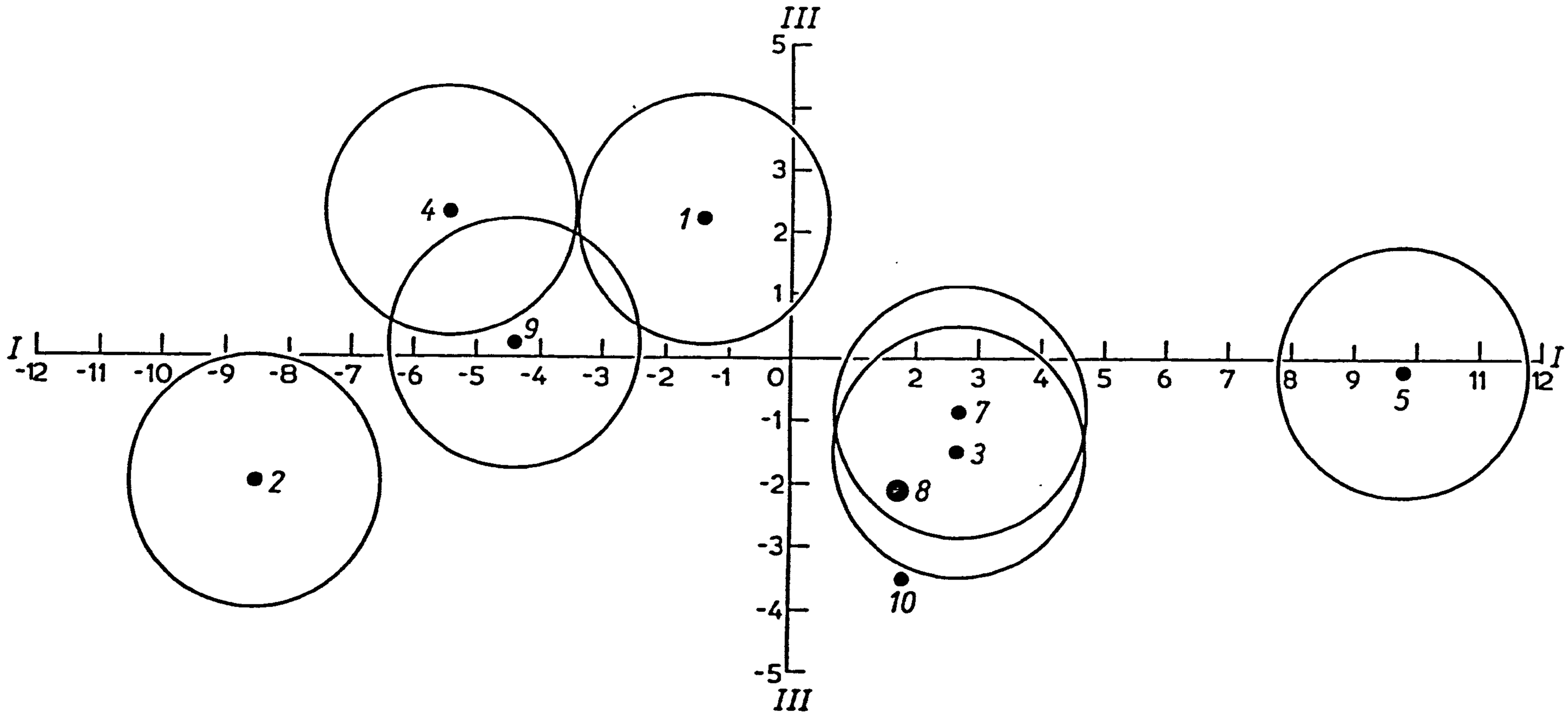
Axis II shows a more compact positioning of the groups along this axis. The Laetoli Hominid 18 cranium and the sub-Saharan modern groups occupy almost similar positions in the upper right and left hand quadrants respectively, as are the sub-Saharan and Middle East early Upper Pleistocene groups in the lower left and right hand quadrants respectively. The North African Upper Pleistocene and European early Upper Pleistocene groups also occupy almost similar positions in the lower right hand quadrant, as are Pekin *Homo erectus* and the Middle East later Upper Pleistocene groups in the upper right and left hand quadrants respectively. The sub-Saharan

later Upper Pleistocene and the Far East/Australia Upper Pleistocene groups are close to each other in the upper left hand quadrant.

Maximum separation of (8.5) units along Axis II is between Laetoli Hominid 18 at the positive limit and the European early Upper Pleistocene group at the negative limit. Closer to Laetoli Hominid 18 is the sub-Saharan modern group, separated by (0.6) units. The Pekin *Homo erectus*, Middle East and sub-Saharan later Upper Pleistocene and Far East/Australia Upper Pleistocene groups are separated by (1.9), (2.3), (3.4) and (4.3) units respectively from Laetoli Hominid 18. Axis II, unlike Axis I, clearly separates Laetoli Hominid 18 from the more archaic *Homo sapiens* and Pekin *Homo erectus* groups and places it closer to the sub-Saharan modern group.

The plot of Axes I and III (Fig. 22), is of interest in that Laetoli Hominid 18 is closely clustered to the Middle East and European early Upper Pleistocene groups within the lower right hand quadrant. The plot reveals further a much more compact clustering of the groups with most of the separation being influenced by Axis I. Pekin *Homo erectus* group is still well separated within the upper and lower right hand quadrants, whereas, the sub-Saharan early and later Upper Pleistocene groups, together with sub-Saharan modern, Middle East later Upper Pleistocene and Far East/Australia Upper Pleistocene

FIGURE 22: Plot of the canonical variate analysis, Axis I and III:
Laetoli Hominid 18 cranium compared with other hominid groups.



groups form an overlapping spread within the upper and lower left hand quadrants.

The maximum separation of (5.8) units along Axis III is between North African Upper Pleistocene group at the negative limit and the Middle East later Upper Pleistocene group at the positive limit. Laetoli Hominid 18 is separated from the sub-Saharan later Upper Pleistocene by only (0.1) units and (0.6) units from the Middle East early Upper Pleistocene group. The furthest group from Laetoli Hominid 18 along Axis III is the Middle East later Upper Pleistocene group, followed by the sub-Saharan early Upper Pleistocene group separated by (4.4) and (4.3) units respectively.

The plot of the groups along Axes I and IV, I and V and I and VI (23-25) present with still more compact positioning of the groups, with most of the spread resulting from the positioning of the groups on Axis I. Thus, the distances between the group means along Axes IV, V and VI is small. However, the separation along Axis VI is of interest in that Laetoli Hominid 18 is again well separated from the rest of the groups, the closest group to it being that of the Far East/Australia Upper Pleistocene separated by (2.7) units and is followed by sub-Saharan modern group separated by (3.0) units.

Vector loadings of the original characters on canonical variates I-VI are given in Table 14. Examination of Axis I, reveals that high loadings on this axis are those

FIGURE 23: Plot of the canonical variate analysis, Axis I and IV:
Laetoli Hominid 18 cranium compared with other hominid groups.

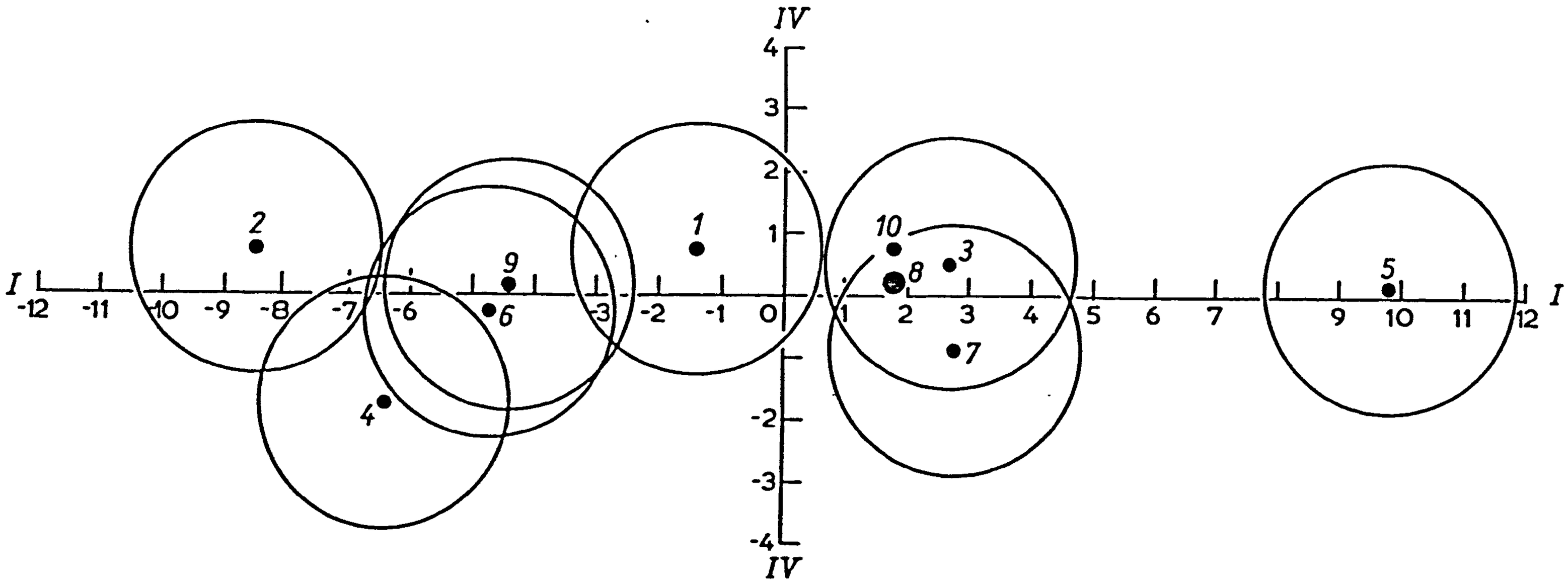


FIGURE 24: Plot of the canonical variate analysis, Axis I and V:
Laetoli Hominid 18 cranium compared with other hominid groups.

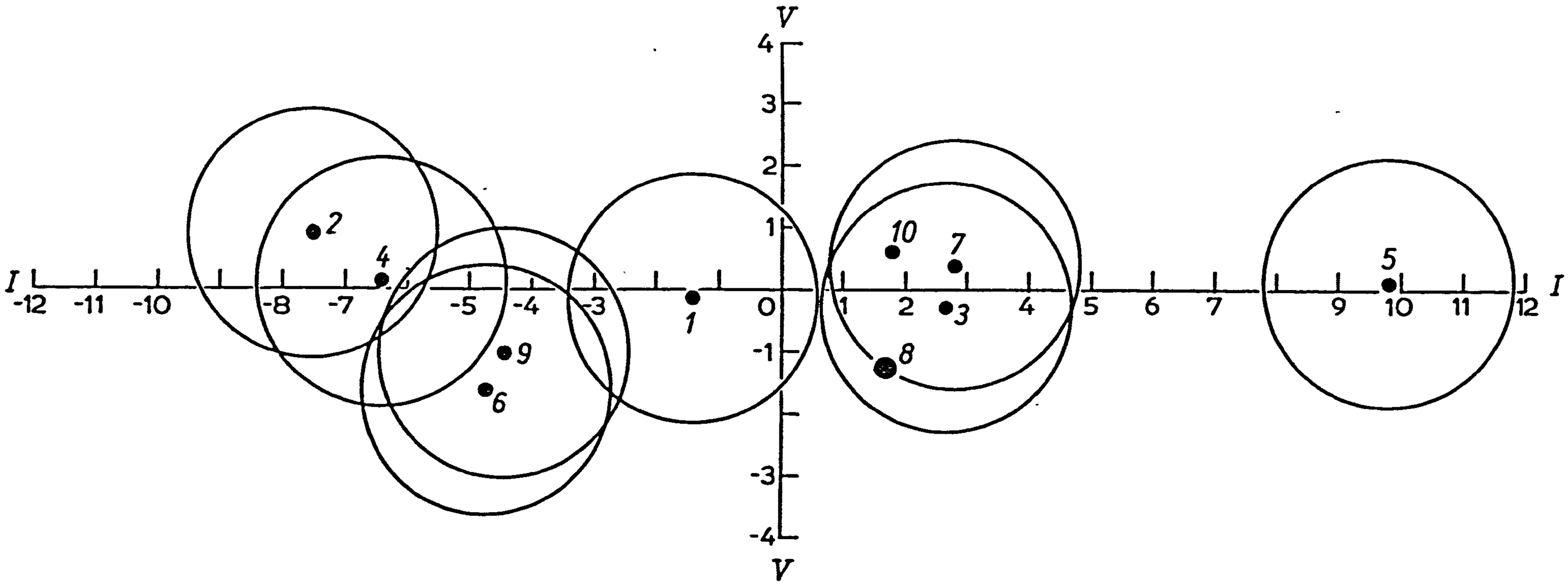


FIGURE 25: Plot of the canonical variate analysis, Axis I and VI:
Laetoli Hominid 18 cranium compared with other hominid groups.

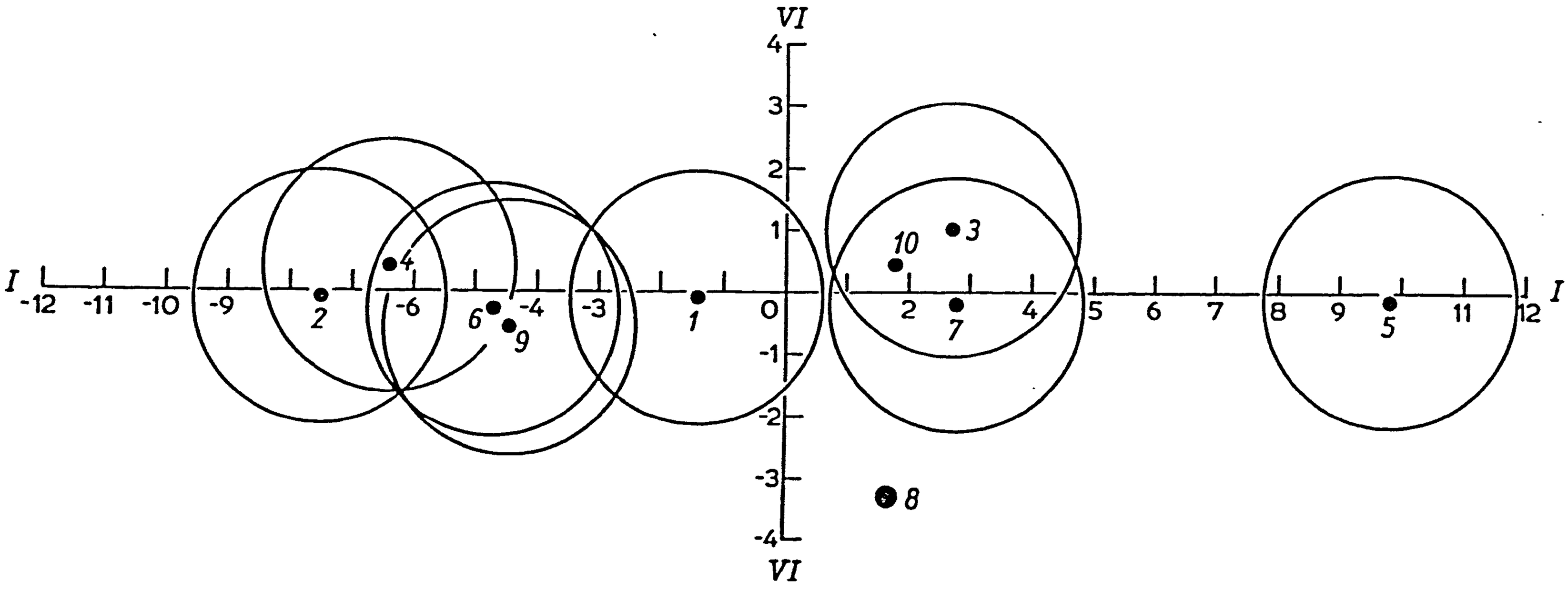


TABLE 14. Vector loadings of the original characters on canonical variates I-VI for the modern and fossil hominid groups

Variables	Axis I	II	III	IV	V	VI
Nasion Bregma Arc (1)	-3.774	-3.341	-0.586	0.175	0.892	1.529
Bregma Lambda Arc (2)	0.683	2.805	-0.964	-3.408	-1.727	-4.720
Glabello-occipital length (4)	2.509	-0.213	-1.945	0.573	-0.635	-1.408
Maximum cranial breadth (6)	-1.134	0.270	-0.360	0.103	0.939	-0.414
Maximum frontal breadth (7)	0.527	-1.911	-0.852	0.158	0.628	0.530
Nasion Bregma chord (8)	4.386	3.439	0.255	-0.729	-0.728	-1.663
Bregma lambda chord (11)	-5.930	-2.262	2.398	2.651	1.729	5.149
Glabella Projection (16)	1.263	-0.219	0.105	-1.022	0.207	0.252
Supraorbital projection (17)	-1.784	-1.196	3.083	0.206	-0.055	0.693
Interorbital breadth (18)	1.179	-1.052	0.391	-0.196	-0.086	1.128

of characters 1, 4, 8, 11 and 17. The highest loading of (-5.930) is that for character (11), bregma lambda chord and is followed by (8), nasion bregma chord with a loading of (4.386), character (1), nasion bregma arc (-3.774), (4), glabello-occipital length (2.509) and character (17), supraorbital projection (-1.784). Thus, the highest loadings on Axis I are those describing the overall size and shape of the cranial vault, the size and shape of the frontal and parietal bones and the degree of development of the supraorbital region. This explains the marked separation of the Laetoli Hominid 18 cranium from the sub-Saharan modern, sub-Saharan later Upper Pleistocene, Middle East later Upper Pleistocene, Far East/Australia Upper Pleistocene and the Pekin *Homo erectus* groups on the one hand and the closeness of the Laetoli Hominid 18 cranium to the Middle East early Upper Pleistocene, European early Upper Pleistocene, sub-Saharan early Upper Pleistocene and the North African Upper Pleistocene groups on the other hand.

The separation of the Laetoli Hominid 18 cranium from the sub-Saharan modern, the sub-Saharan later Upper Pleistocene, the Middle East later Upper Pleistocene and the Far East/Australia Upper Pleistocene appears to be due to the overall size and shape of the cranial vault, variable (4), the size and shape of the frontal bone, variables (1) and (8), the size and shape of the parietal bone, variable (11) and the size and shape of the supra-orbital torus, variable (17). Thus, the Laetoli Hominid 18

cranium as previously shown by the univariate and bivariate analyses is characterised by a long cranium, long and flattened frontal and parietal bones and with well developed supraorbital torus. The above features of the Laetoli Hominid 18 cranium appear to separate it from the above mentioned hominid groups. The sub-Saharan later Upper Pleistocene, the sub-Saharan Modern, the Middle East later Upper Pleistocene and the Far East/ Australia Upper Pleistocene groups unlike the Laetoli Hominid 18 have relatively short crania, curved frontals, long and curved parietal bones and with less developed supraorbital tori. The Pekin *Homo erectus* group unlike the Laetoli Hominid 18 cranium has short crania, short and flattened frontal bones and parietal bones and with much more developed supraorbital tori.

Closeness of the Laetoli Hominid 18 cranium to the North African Upper Pleistocene, the sub-Saharan early Upper Pleistocene, the European and the Middle East early Upper Pleistocene groups appears to be due to the overall size and shape of the cranium, the size of the frontal bone and the development of the supraorbital tori. Thus, the above groups like the Laetoli Hominid 18 cranium are characterized by long crania, long frontal bones and developed supraorbital tori.

High loadings on Axis II are those of characters 1, 2, 7, 8 and 11. The highest loading (3.439) is that of character (8), nasion bregma chord and is followed by

character (1) nasion bregma arc (-3.341), character (2) bregma lambda arc (2.805), character (11) bregma lambda chord (-2.262) and character (7) maximum frontal breadth (1.911). Axis II appears to be discriminating almost entirely on the basis of the shape and size of the frontal and parietal bones. This explains the separation of the Laetoli Hominid 18 from the sub-Saharan early, the Middle East early Upper Pleistocene, the European early Upper Pleistocene and the North African Upper Pleistocene groups on the one hand and the closeness of the Laetoli Hominid 18 cranium to the sub-Saharan modern group on the other. The marked separation of the Laetoli Hominid 18 from the North African Upper Pleistocene, sub-Saharan early Upper Pleistocene, Middle East early Upper Pleistocene and the European early Upper Pleistocene groups appears to be due to the overall size and shape of the parietal bone and to some extent to the shape of the frontal bone. Thus, the above groups unlike the Laetoli Hominid 18 cranium have relatively short and flattened parietals with relatively curved frontal bones. The Laetoli Hominid 18 cranium has relatively long, flattened parietals. The closeness of the Laetoli Hominid 18 to the sub-Saharan modern group appears to be due to the size of the frontal bone and parietal bones. However, the two groups differ very much in the profiles of their frontal and parietal bones, whereby the frontals and parietals in the sub-Saharan modern group are relatively curved while in the Laetoli Hominid 18 cranium, the two bones are flattened.

Separation along Axis III, is due to the loadings of characters 2, 4, 11 and 17. The highest loading of (3.083) is that of character (17), supraorbital projection and is followed by (11) bregma lambda chord with a loading of (2.397), character (4) glabello-occipital length (-1.945) and character (2) bregma lambda arc (-0.964). Axis III, like I, appears to be discriminating on the basis of the development of the supraorbital region, the overall size and shape of the cranium and on the size and shape of the parietal bone. This explains the closely clustered positions of the Laetoli Hominid 18 cranium to the Middle East Upper Pleistocene and the European early Upper Pleistocene groups as they all have long crania with well developed supraorbital regions.

Loadings on Axes IV, V and VI bring about small separations amongst the groups. However, high loadings on Axis VI significantly separate the Laetoli Hominid 18 cranium from the rest of the groups. Axis VI, Like I, appears to be discriminating on the basis of the overall size and shape of the cranium, the size and shape of the parietal and the frontal bones. Thus, this explains the divergence of the Laetoli Hominid 18 cranium from the sub-Saharan modern, sub-Saharan later Upper Pleistocene, sub-Saharan early Upper Pleistocene and the Pekin *Homo erectus* groups.

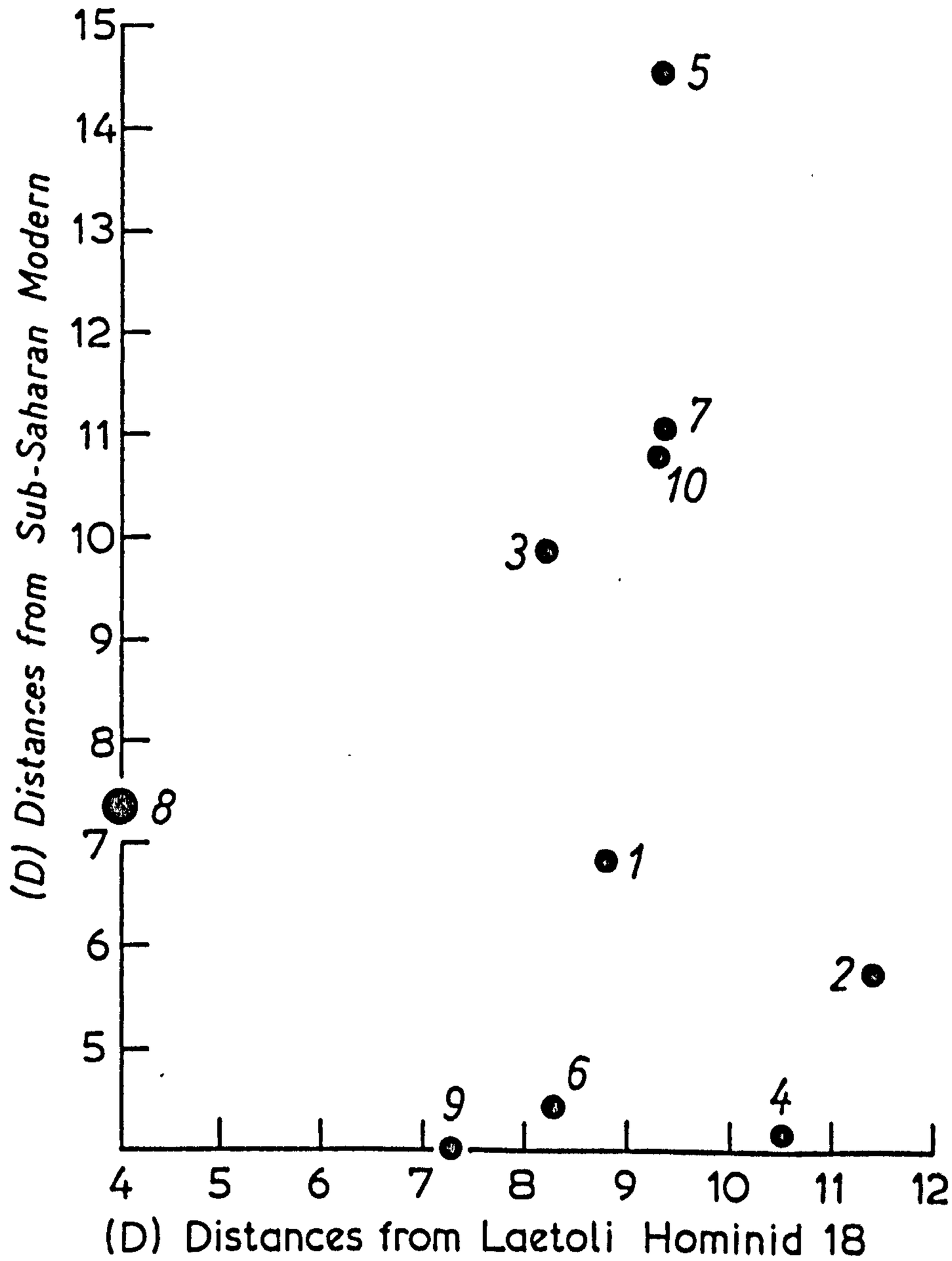
As a whole, the canonical axes discriminate effectively between the Hominid cranial groups considered. Inspection

of the matrix of (D) distances (Table 15 and Figures 26-31) reflects more clearly the separation of the Laetoli Hominid 18 cranium from the sub-Saharan modern, sub-Saharan later Upper Pleistocene and the Pekin *Homo erectus* groups. Thus, considering the sub-Saharan modern group as a reference group, the following order of the groups is formed from it; the Middle East later Upper Pleistocene group followed by the Far East/Australia Upper Pleistocene, the sub-Saharan later Upper Pleistocene, sub-Saharan early Upper Pleistocene, the Laetoli Hominid 18, the Middle East early Upper Pleistocene, North African Upper Pleistocene, European early Upper Pleistocene and the Pekin *Homo erectus* groups. Thus, the matrix of (D) distances show that the Laetoli Hominid 18 cranium and the sub-Saharan early Upper Pleistocene groups are equidistant from the sub-Saharan modern crania. The North African Upper Pleistocene, the European Upper Pleistocene and the Middle East early Upper Pleistocene groups are also equidistant from the sub-Saharan modern groups as are the Middle East later Upper Pleistocene, the Far East/Australia Upper Pleistocene and the sub-Saharan later Upper Pleistocene groups. The Pekin *Homo erectus* group occupies the furthest distance from the sub-Saharan modern group.

TABLE 15. Matrix of (D) distance: sub-Saharan modern and fossil hominid groups

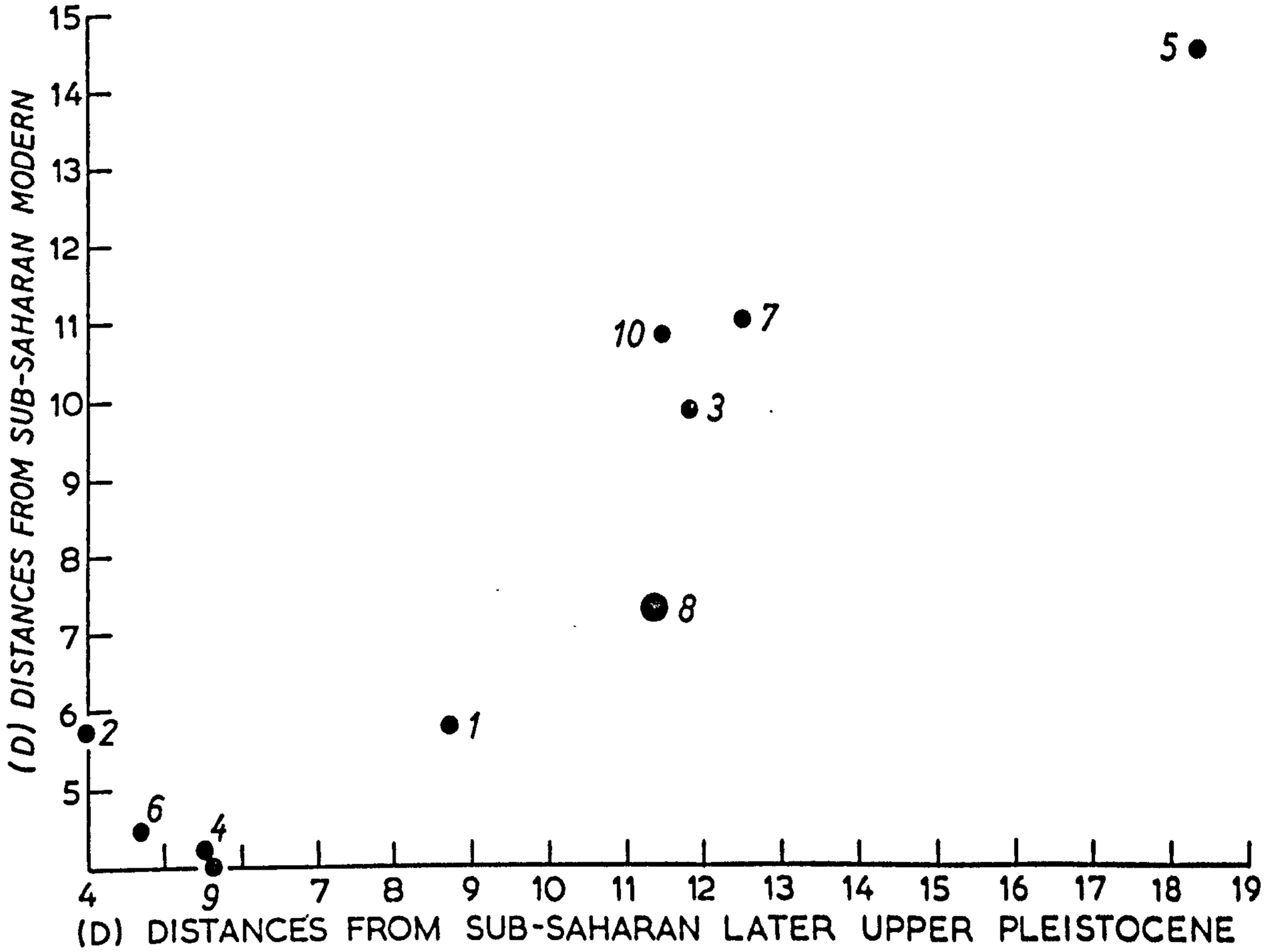
Sub-Saharan Modern	(9)	0.00									
Middle East Later Upper Pleistocene	(4)	4.26	0.00								
Far East/Australia Upper Pleistocene	(6)	4.61	5.68	0.00							
Sub-Saharan later Upper Pleistocene	(2)	5.58	5.54	4.74	0.00						
Sub-Saharan early Upper Pleistocene	(1)	7.16	6.82	5.99	8.72	0.00					
Laetoli Hominid 18 cranium	(8)	7.28	10.53	8.31	11.44	8.78	0.00				
Middle East early Upper Pleistocene	(3)	10.15	11.11	8.05	11.77	5.65	8.16	0.00			
North African Upper Pleistocene	(10)	11.05	12.00	8.14	11.48	6.93	9.31	2.86	0.00		
European early Upper Pleistocene	(7)	11.28	11.55	8.92	12.51	5.93	9.47	2.50	3.35	0.00	
Pekin *Homo erectus*	(5)	14.68	16.53	14.89	18.42	12.17	9.18	8.78	10.71	9.58	0.00
		(9)	(4)	(6)	(2)	(1)	(8)	(3)	(10)	(7)	(5)

FIGURE 26



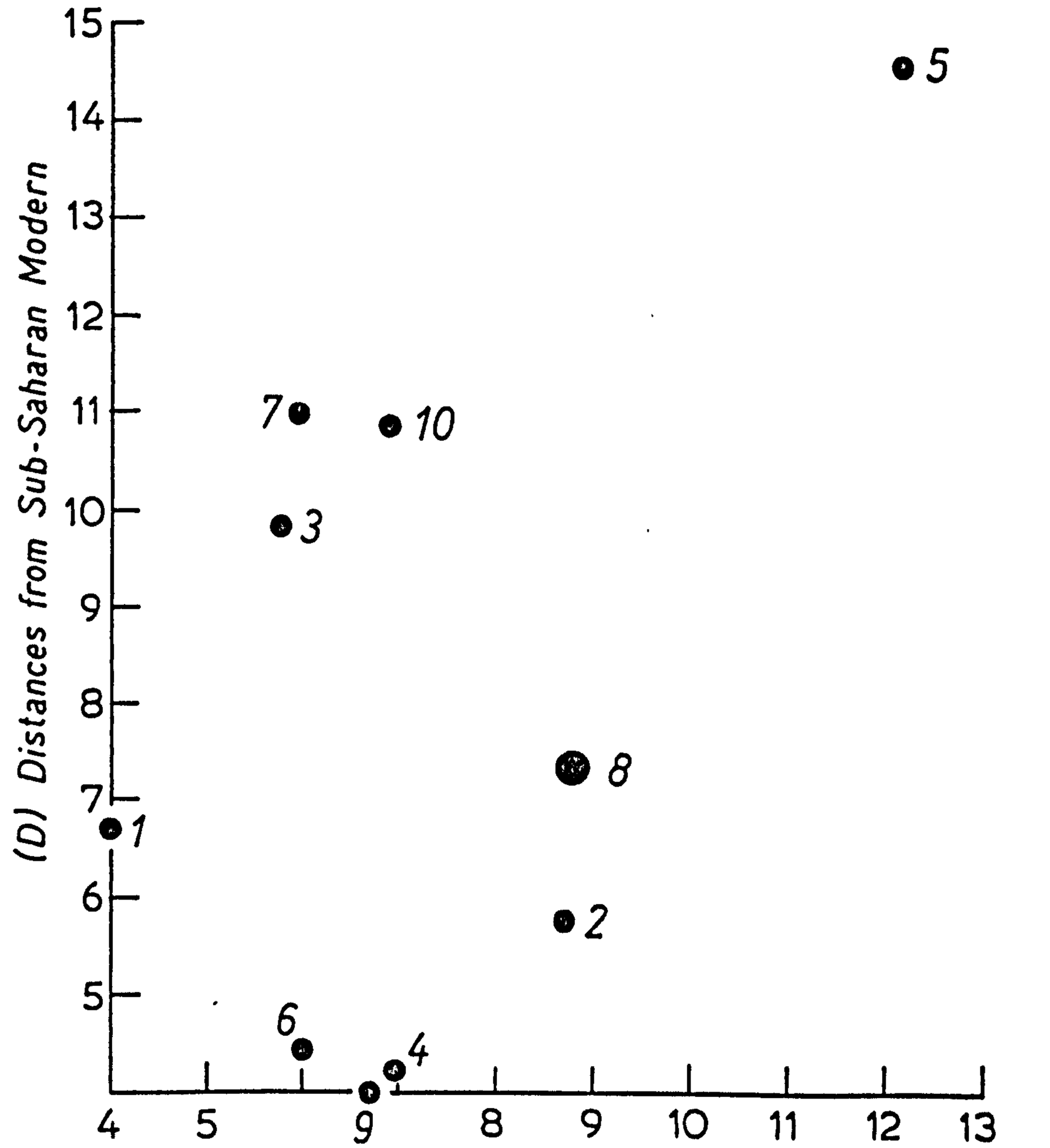
Plot of the (D) distances: Laetoli Hominid 18 cranium/sub-Saharan modern group.

FIGURE 27



Plot of the (D) distances: sub-Saharan later Upper Pleistocene group/ sub-Saharan modern group.

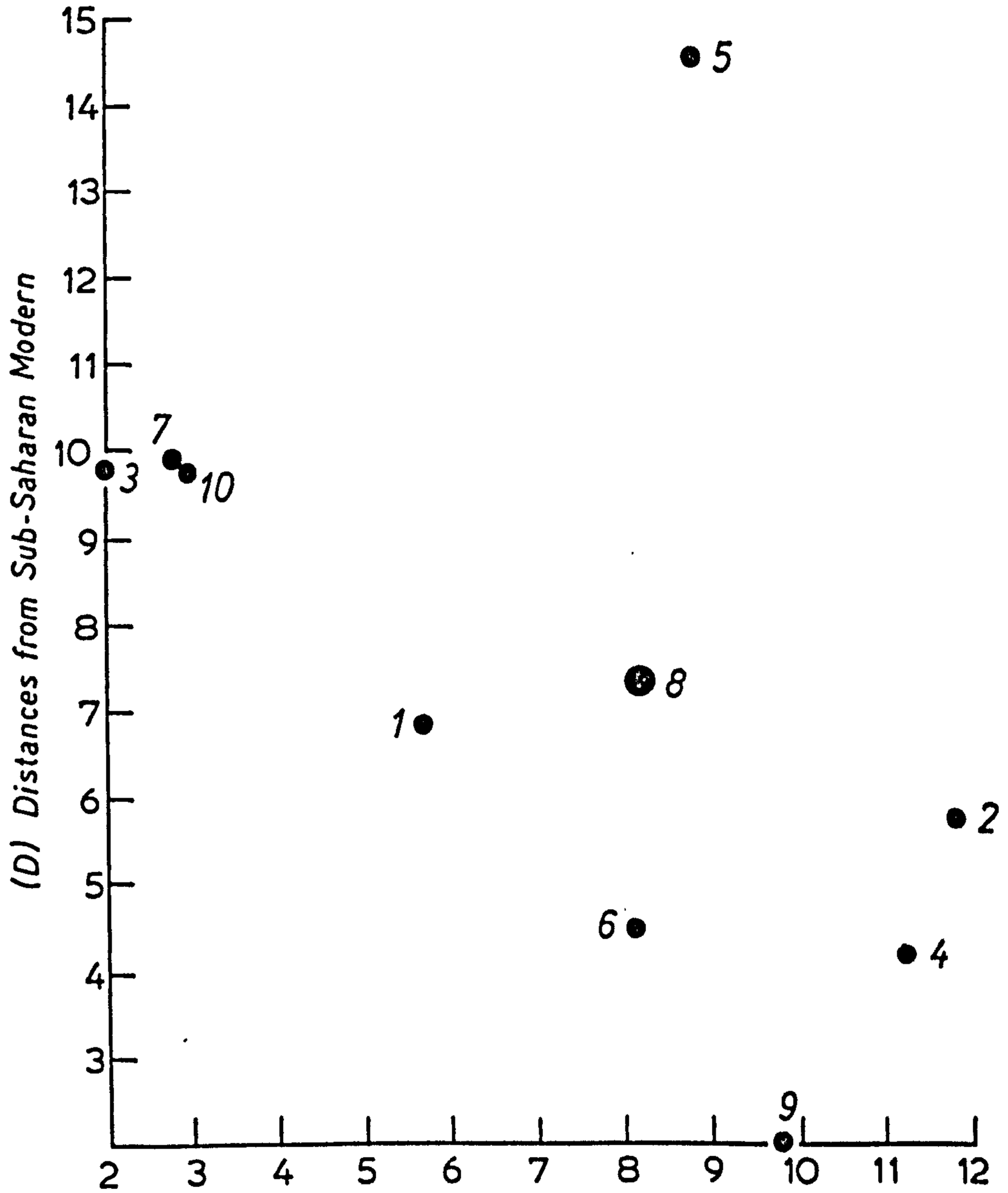
FIGURE 28



(D) Distances from Sub-Saharan Early Upper Pleistocene

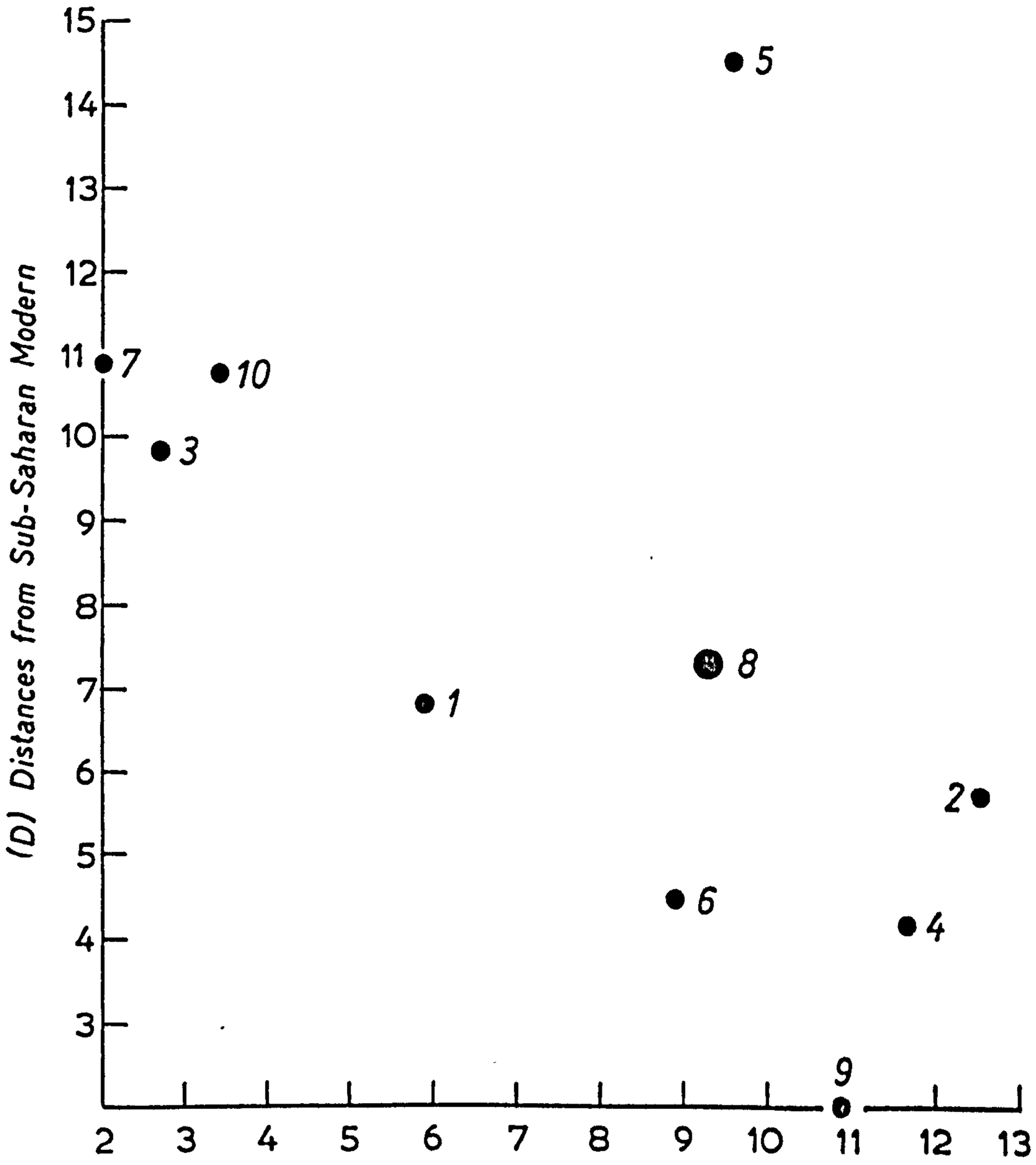
Plot of the (D) distances: sub-Saharan early Upper Pleistocene/ sub-Saharan modern group.

FIGURE 29



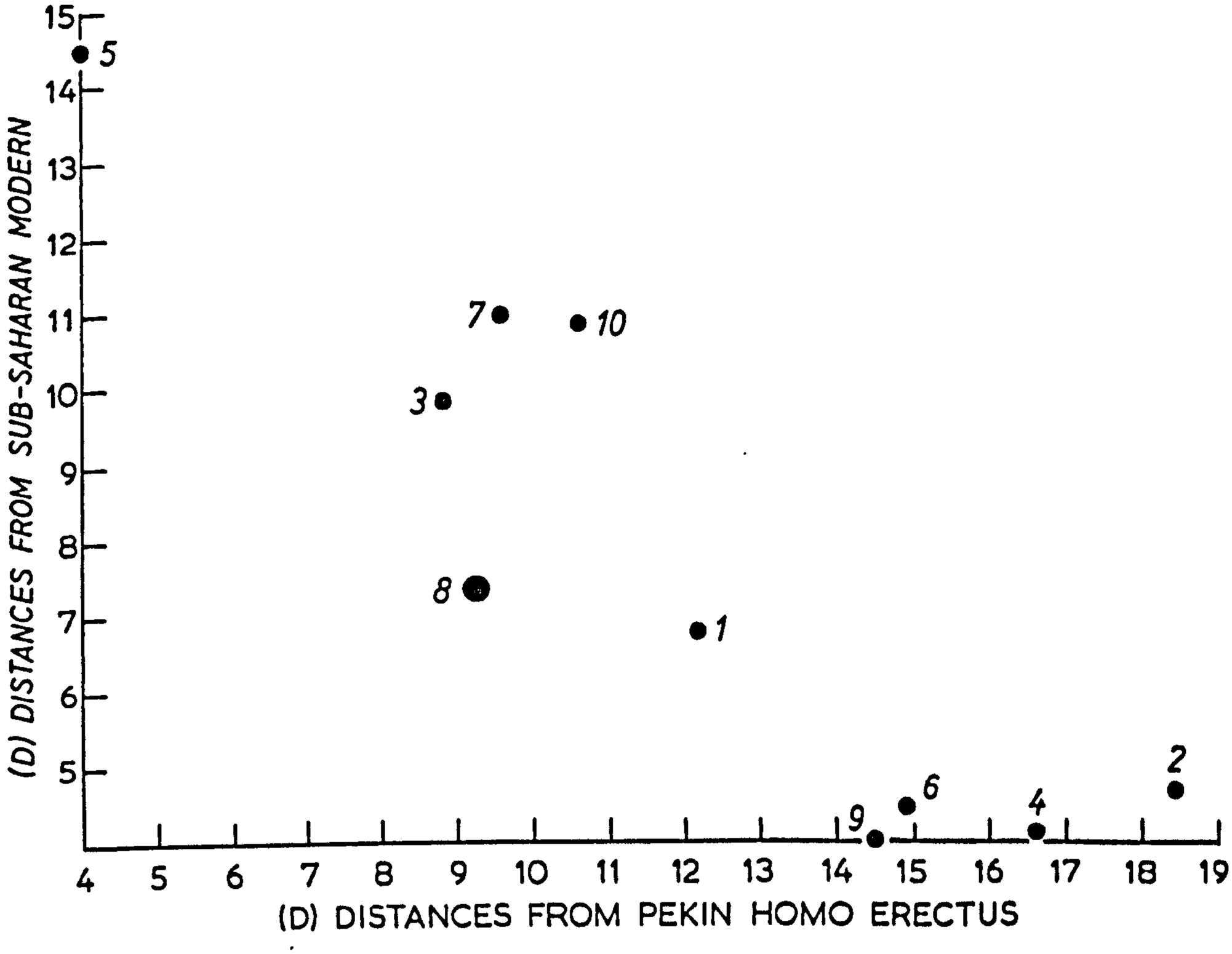
Plot of the (D) distances: Middle East early Upper Pleistocene/ sub-Saharan modern group.

FIGURE 30



Plot of the (D) distances: European early Upper Pleistocene/ sub-Saharan modern group.

FIGURE 31



Plot of the (D) distances: Pekin *Homo erectus*/ sub-Saharan modern group.

VI. DISCUSSION

The recovery in 1976 of the Laetoli Hominid 18 cranium from the Ngaloba Beds of Northern Tanzania has proved to be a valuable and significant contribution to the fossil record of man already known from the continent of Africa; it is also of particular significance since its estimated age of 120,000 ± 30,000 yr B.P. (Day et al., 1980) places it in an era of human evolution that is in need of fossil evidence. The commonly held view that *Homo erectus* evolved into *Homo sapiens* by the process of successive evolution, along the lines of the Darwinian 'phyletic gradualism' model may be in need of modification if the views of Eldredge and Gould (1972) and their punctuated equilibrium theory are applied to the fossil record of the *Homo erectus* - *Homo sapiens* transition. Evidence for the mosaic evolutionary process would tend to favour the discontinuous model of differential change within species, and this in turn could be reflected in the differential development of the morphological features of individuals in the transitional group. The combination of morphological and metrical features discovered in this cranium would seem to be best explained by the mosaic evolutionary theory since there are clearly both archaic and modern features that can be observed together in this skull.

A second reason for the particular significance of this newly recovered cranium is the possession of

sufficient of the facial skeleton to enable a reconstruction to be made. While aspects of this reconstruction must be regarded as speculative (in particular the relationship between the calvarium and the face) specimens of this apparent age with facial remains are few and opportunities for comparisons are rare. The technical problems posed by the Laetoli Hominid 18 cranium were not formidable but required patience, care and great attention to detail. The use of the controlled acid development technique resulted finally in clean fossil since the calcereous matrix adherent to the surface, and blocking the foramina, softened and finally submitted to acid erosion.

The differential acid-erosive technique is very effective but must be carried out under direct vision (by eye or dissecting microscope), strict time control and with adequate washing subsequent to acid immersion.

Experiments carried out in Nairobi by Walker (personal communication) had established that the matrix would yield to acetic acid and experiments in London established that a 3% dilution of acetic acid would be most effective. The cleared and exposed natural bony surface has been preserved with 'Bedacryl' to prevent surface damage.

Reconstruction of the cranium was complicated by the plastic deformation of the frontal region, nonetheless almost every fragment recovered has been fitted into the final reconstruction on the basis of the identification of "interlocking fits" of fragments along fracture lines and

separated sutures. Care was taken to secure the fragments with acetone soluble glue so that the reconstruction reported and discussed here can be dismantled and reassembled should new evidence come to light that demands a new reconstruction.

Radiographic analysis assisted in the visualization of the internal structure of the cranium and also the extent and form of the frontal and maxillary air sinuses. The fossil proved to be heavily mineralised and posed some problems of technique (Brothwell et al., 1969) that were successfully overcome.

The problems of comparison and measurement faced in this study were no different from those faced previously by other workers - the availability of suitable comparative materials, both fossil and recent, and the limitations of the techniques of craniometry in terms of standardisation, accuracy, repeatability and the clear definition of the available craniometric points.

Wherever possible original comparative materials were examined and measured; these included the Singa Skull, Kabwe, Tabūn I, Wadjak I and Swanscombe. The remainder of the fossil comparative sample was studied from casts. The absence of a suitable collection of modern skulls from East Africa necessitated the use of three samples drawn from Africa as a whole, the Ngoni, Ashanti and Kaffir groups, most of which are likely to be adult male skulls, since the collections arose from tribal wars. The osteometric technique used was that of

Howells (1973) and followed by Stringer (1974a) so that comparability with these studies could be achieved on the basis of similar methodology.

A. COMPARATIVE ANATOMY

At first glance the Laetoli Hominid 18 cranium discloses features that mark it out to be of evolutionary interest. Clearly it is a long, low vaulted skull with some frontal recession, parietal expansion and occipital rounding. Closer examination reveals small mastoid processes and a divided frontal ridge among the significant features that merit particular attention, since they will likely prove to be of taxonomic significance.

(a) Brow Ridge Development

Much has been reported in the literature regarding the variation in the form and size of brow ridge development in different hominid crania, (e.g. Cunningham, 1909 and Weidenreich, 1945). Considering the evolutionary sequence of the human skull as a whole Weidenreich, (1945) reveals the fact that the brain case increased in size while the facial skeleton became correspondingly reduced. The reduction in the face went hand in hand with the reduction of both the masticatory and cervical musculature. The space required for the attachment of those muscles to the skull surface consequently became smaller, and so did

the power of the whole masticatory apparatus. The superstructures which reinforce an archaic skull in the form of either crests or ridges in order to enable it to stand the greater strain of that mechanism, diminished correspondingly. The above evolutionary sequence thus tries to explain why the archaic skulls are characterised by well developed brow ridges compared with more recent skulls with relatively small brow ridges.

The brow ridge of the Laetoli Hominid 18 cranium is moderately developed and it is clearly separable into three components, the glabella, the superciliary and the supraorbital portions. In this respect, the brow ridge development in the Laetoli Hominid 18 corresponds to Type II (Cunningham, 1909). This is well in advance of those examples of *Homo erectus* (Java, Peking, Olduvai 9) that have massive continuous tori; somewhat in advance of those early African sapients such as Kabwe (Woodward, 1921), Omo 2 (Day, 1969), Singa (Brothwell, 1974) and Saldanha (Singer, 1954), and more in line with Omo I (Day, 1969), Eyasi I (Kohl-Larsen and Reck, 1936) and the Fish Hoek skull (Keith, 1931). In Europe the classic Neanderthalers also have heavy brow ridges and this led to the early view that this indicated Neanderthal affinities, even in skulls recovered from the Far East (von Koenigwald, 1958). A more modern view would regard the development of the brow ridges as part of the structural system reviewed for the dissipation of chewing stresses through the face and on the skull in forms with restricted frontal development.

While it is true that the mandible of the Laetoli Hominid 18 cranium is not available for study, the form of the maxilla and its restricted sub-nasal prognathism, may indicate that reduction in the dento-gnathic complex, coupled with the general cranial enlargement is leading towards the break-up of the primitive torus into its component parts. In this feature, therefore, the Laetoli Hominid 18 cranium is clearly intermediate in its form between that of *Homo erectus* and modern *Homo sapiens*, though probably nearer to the modern type.

(b) Frontal Recession

A low receding forehead is common to all *Homo erectus* crania and to very many African fossil *Homo sapiens* crania such as Kabwe, Omo 2, Omo I, Florisbad, Eyasi I, Iwo Eleru and Djebel Irhoud. However, the frontal recession shown by Laetoli Hominid 18 cranium is less than that shown by Kabwe, Omo 2 and Saldanha and more than that shown by Omo I and Florisbad, which tend to be both higher, more curved and show some evidence of frontal bossing. Closer still to the modern sapient condition are the Singa skull, the Fish Hoek and Matjes River crania. European classic Neanderthal skulls such as La Chapelle-aux-Saints, La Ferrassie, Gibraltar I and Le Moustier tend to have higher vaults and more curved frontals. In this respect, therefore, the Laetoli Hominid 18 cranium tends to have affinities with the more archaic comparative material examined.

(c) The Parietal Profile

The anterior parietal profile of the Laetoli Hominid 18 cranium is relatively flattened, but posteriorly, the profile is well rounded and is marked by well developed mid-parietal bossing. In the posterior parietal profile, the Laetoli Hominid 18 cranium resembles modern *Homo sapiens* crania and differs considerably from most of the early *Homo sapiens* crania. Closer to the Laetoli Hominid 18 cranium in the posterior parietal profile are the Omo I and the Eyasi I crania. The Kabwe, Omo 2 and Saldanha crania, unlike the Laetoli Hominid 18 cranium, present with sloping parietal profiles and with only minimal parietal bossing. This latter group of the early African *Homo sapiens* crania are comparable to some of the European classic Neanderthal crania such as La Chapelle-aux-Saints, La Ferrassie and Le Moustier in general parietal form. The O.H. 9 and the Pekin *Homo erectus* crania, unlike the Laetoli Hominid 18, present with much more flattened parietals that show no sign of bossing. In this respect, therefore, the general cranial expansion of the Laetoli Hominid 18, as reflected in its cranial capacity (1200 cc), is relatively advanced and the maximum cranial transverse diameter is found high on the vault profile.

(d) The Occipital Profile

The occipital profile of the Laetoli Hominid 18 cranium is well filled and almost evenly rounded. In this respect, the Laetoli Hominid 18 cranium is again

closer to modern *Homo sapiens* crania. Fossil crania showing resemblances to the Laetoli Hominid 18 cranium in the occipital bone profile include, the Omo I, Eyasi I, Singa, Iwo Eleru, Matjes River and Fish Hoek. The other early African *Homo sapiens* crania such as Kabwe and Omo 2 differ remarkably from the Laetoli Hominid 18 cranium. In these, the occipital profile slopes posteriorly and is not evenly rounded and tends to have a profile that is divided into two portions, an upper curved occipital portion and a lower flattened nuchal portion separated by a pronounced occipital torus that may even be undercut. Similarly, most of the European classic Neanderthal crania such as the La Chapelle-aux-Saints, La Ferrassie, Spy 2, Le Moustier and La Quina V present with occipital profiles marked by a chignon or a "bun" formation characteristic of the group. The O.H.9 and the Pekin *Homo erectus* crania present with angulated occipital profiles and differ very much from the Laetoli Hominid 18 cranium. Thus in the *Homo erectus* crania, the occipital profile is poorly filled, angulated and the inion coincides with the opisthocranion. The differences in the occipital profiles of the hominid crania discussed above can be explained on the principles of Delattre and Fenart (1960), who have shown how in the ontogeny and growth of an anthropoid cranium, with little cerebral expansion and with heavy ectocranial embellishments, the inion is carried progressively farther from its foetal or neonatal starting-point. In this way the nuchal segment increases at the expense of the

occipital component. In modern man with much greater cerebral expansion and no marked migration up the calvaria of the nuchal muscles, the opposite process occurs, hence, the upper occipital segment of the squama increases at the expense of the lower nuchal component.

(e) Occipital Torus

Weidenreich (1940) defines the occipital torus as any continuous transverse ridge marking the boundary between the occipital and the nuchal planes, regardless of the degree of development. The form and size of the occipital torus in different hominid groups is explained on the same principles as discussed for the development of the brow ridge (Weidenreich, 1945). The occipital torus of the Laetoli Hominid 18 cranium is moderately developed, undercut and centrally limited. In this respect, the Laetoli Hominid 18 cranium differs greatly from most of the early African *Homo sapiens* crania such as Kabwe and Omo 2 and tends to show resemblance to the early European fossil crania such as Swanscombe (Stewart, 1964).
The Kabwe cranium, unlike the Laetoli Hominid 18 cranium, presents with a well developed, angulated and naturally continuous occipital torus with a supramastoid crest. The upper border of the occipital torus in the Kabwe cranium is limited by a supratoral sulcus whereas the inferior border is curved. In the Omo 2 cranium, the occipital torus, unlike in the Laetoli Hominid 18 cranium, is massively developed and more protuberent centrally. As in the Kabwe cranium, the torus extends laterally and joins

with the supramastoid crest. In Europe, the classic Neanderthalers also have developed occipital tori and this has led to the present view that they indicate Neanderthal affinities (Stewart, 1964 and Santa Luca, 1978). In the classic Neanderthal skulls, the occipital torus is of a uniform vertical thickness and is limited to the central portion of the occiput. Laterally, the torus thins and fades without joining the supramastoid crest. The O.H.9 and the Pekin *Homo erectus* crania have massively developed, angulated and centrally thickened occipital tori. Laterally, the tori are continuous with the supramastoid crests. Thus, considering occipital torus development, the Laetoli Hominid 18 cranium diverges from the early African *Homo sapiens* crania and shows some resemblance to Neanderthal crania.

(f) The Occipitomastoid Crest

The Laetoli Hominid 18 cranium possesses a well developed occipitomastoid crest that runs along the occipitomastoid suture and is limited laterally by deeply incised digastric fossae. The occipitomastoid crest in this cranium is larger and projects further downwards than the mastoid process. The presence of a developed occipitomastoid crest in the Laetoli Hominid 18 cranium appears to be a unique feature in this individual as compared to other early African *Homo sapiens* crania such as the Kabwe, Omo 2, Iwo Eleru, Singa, Fish Hoek and Matjes River. In these, only the Singa skull presents

with a developed occipitomastoid crest, as in the Laetoli Hominid 18 but unlike the latter, the size and the degree of projection is less remarkable. In Europe, Neanderthal crania present with developed occipitomastoid crests and this too has led to the view that they indicate Neanderthal affinity (Stewart, 1964 and Santa Luca, 1978). In the Far East (Weidenreich, 1943) also regarded the presence of a developed occipitomastoid crest as a feature of Pekin man. Apart from the European Neanderthaler crania, the Middle East early *Homo sapiens* crania such as the Shanidar I (Stewart, 1959) and Tabūn I (McCown and Keith, 1939) also present with developed occipitomastoid crests. In this respect, the Laetoli Hominid 18 cranium is again closer to more archaic *Homo sapiens* groups than to modern *Homo sapiens* crania.

(g) Development of the Mastoid Process

The mastoid processes in the Laetoli Hominid 18 cranium are comparatively small. In this respect, the cranium differs from most modern *Homo sapiens* crania with larger mastoid processes that project slightly downwards and medially at the cranial base. The mastoid development of the Laetoli Hominid 18 cranium is comparable to that of the Eyasi I, Singa, Iwo Eleru, Djebel Irhoud, Matjes River and Fish Hoek crania. The Kabwe and the Omo 2 crania, unlike the Laetoli Hominid 18 cranium present with large mastoid processes as a whole. Some of the classic Neanderthal crania such as the La Chapelle-aux-Saints,

La Ferrassie and Gibraltar I resemble the Laetoli Hominid 18 cranium in the size of the mastoid process.

(h) The Facial Skeleton

The facial skeleton of the Laetoli Hominid 18 cranium is only moderately developed. The maxilla presents with some degree of subnasal prognathism. The palate is deep and moderately widened and the dental arcade is U-shaped. The facial skeletal development of the Laetoli Hominid 18 cranium falls within the range of modern *Homo sapiens* crania and differs very much from that of the Kabwe, *Homo erectus* crania and the classic Neanderthal crania. In the *Homo erectus* crania, the facial skeleton is relatively small though broad, the bones are robust, the malar pillars are broad, and the zygomatics are high. The Kabwe cranium unlike the Laetoli Hominid 18 cranium presents with large facial bones, the maxillae are inflated, the palate is large and with alveolar prognathism. In Florisbad, the facial skeleton is moderately prognathous, the malars are large and set nearly perpendicular to the maxillary body and laterally directed. The classic Neanderthals, on the other hand, present with more robust, flattened maxillae. The malar bone springs off from the body of the maxilla at an angle of less than 90^{o} compared to the Laetoli Hominid 18 cranium where this angle is more than 90^{o}. The palate in the classic Neanderthaler crania is large, wide and deep.

(i) The Endocranial Cast and the Cranial Capacity

In its general form, the endocranial cast of the Laetoli Hominid 18 cranium closely resembles that of modern *Homo sapiens*. The overall aspect of the endocranial cast of the Laetoli Hominid 18 cranium gives an impression of an ill-filled skull as is seen in some modern crania. Anteriorly, the cerebral surface of the endocranial cast is flattened but becomes more rounded posteriorly with well marked occipital poles. The convolutional impressions are well marked at the anterior region of the frontal lobes. The cast is widest at the temporal region and shows well marked parietal eminences as are in the modern *Homo sapiens* crania. The pattern of the meningeal vessels is well marked on the endocranial cast and corresponds closely to that of modern *Homo sapiens*. This pattern of the meningeal vessels also closely resembles that of the Omo 2 cranium but differs considerably from that of the Swanscombe (Brothwell, 1964), Rabat man, La Ferrassie and Djebel Irhoud (Saban, 1977). The dural sinuses in the sagittal and occipital regions are of the arrangement commonly found in modern man.

The cranial capacity of 1200 cc of the Laetoli Hominid 18 cranium gives an indication of a generally expanded brain and places Laetoli closer to modern *Homo sapiens* crania. The Laetoli Hominid 18 cranium has a similar cranial capacity to Kabwe, 1280 cc, (Marat, 1928), Saldanha, 1200-1250 cc (Drennan, 1953a) and is also similar to some of the European Neanderthal

crania such as the Swanscombe, 1325 cc (Morant, 1938) and the Steinheim, 1150-1175 cc (Howell, 1960). The classic Neanderthal crania have higher cranial capacities as compared to the Laetoli Hominid 18 cranium.

B. METRICAL COMPARISONS

Univariate Analysis

In this method, each individual measurement taken on the Laetoli Hominid 18 cranium was compared with the corresponding means of the comparative cranial groups. This method of analysis though of fundamental importance to this type of study, posed some problems. The results of the analyses depended wholly on the sample size and the position of the means and ranges of the comparative groups considered. As such, groups with small sample sizes presents with very much inflated ranges and dubious means compared to those with larger sample sizes showing more stable means and ranges. In view of the above problem, the results of the univariate analyses should be regarded with caution. However, the univariate analyses on occasion point out those metrical characters that separate, or bring closer, the Laetoli Hominid 18 cranium to other fossil hominid crania. Such metrical characters of the Laetoli Hominid 18 cranium include those describing the overall cranial length, cranial breadth, glabella and supraorbital projections. These metrical features will now be discussed.

(a) Cranial Length

From the analysis of the glabello-occipital length, the Laetoli Hominid 18 cranium is long compared to modern *Homo sapiens* crania. The overall cranial length of the Laetoli Hominid 18 cranium places it within the range of more archaic crania including O.H.9, sub-Saharan early Upper Pleistocene group, sub-Saharan later Upper Pleistocene, Middle East early Upper Pleistocene, Far East/Australia Upper Pleistocene and the European Upper Pleistocene groups. The Pekin *Homo erectus* group, unlike the Laetoli Hominid 18 cranium, present with relatively shorter crania.

(b) Cranial Breadths

The general impression drawn from the overall cranial breadth measurements of the Laetoli Hominid 18 indicates that measurements covering the frontal region of the cranium fall within the range of the modern *Homo sapiens* crania. Such measurements include the maximum frontal breadth, the minimum cranial breadth, the bifrontal breadth and the interorbital breadth. Also resembling the Laetoli Hominid 18 cranium in the bifrontal breadth and interorbital breadth, measurements include the sub-Saharan later Upper Pleistocene and the Middle East later Upper Pleistocene groups. The sub-Saharan *Homo erectus* and the Pekin *Homo erectus* groups show much wider bifrontal and interorbital breadth measurements compared to the rest of the groups considered, whereas the sub-Saharan early Upper Pleistocene, Middle East early Upper

Pleistocene and the European early Upper Pleistocene groups, unlike the Laetoli Hominid 18 cranium, present with wider interorbital and bifrontal breadth measurements lying intermediate between the sub-Saharan modern and the *Homo erectus* groups. Measurements covering the posterior and basal part of the Laetoli Hominid 18 cranium place it away from the sub-Saharan modern crania. Such measurements include, the maximum cranial breadth, the biauricular breadth and the biasterionic breadth. In these measurements, the Laetoli Hominid 18 cranium lies closer to the archaic *Homo sapiens* groups.

As a whole, the cranial breadth measurements indicate that the Laetoli Hominid 18 cranium shows archaic features in its posterior and basal aspects whereby, it is much wider than modern *Homo sapiens* crania, but anteriorly the cranium shows characters falling within modern *Homo sapiens* cranial range.

(c) Glabella and Supraorbital Projections

Measurements of the glabella and supraorbital projections place the Laetoli Hominid 18 cranium well away from the sub-Saharan modern, the European early Upper Pleistocene, the sub-Saharan *Homo erectus* and the Pekin *Homo erectus* groups. These measurements, on the other hand, place the Laetoli Hominid 18 cranium closer to the sub-Saharan early Upper Pleistocene, the sub-Saharan later Upper Pleistocene and the Far East/Australia Upper Pleistocene groups.

Bivariate Analyses

The bivariate analyses were performed on the frontal and parietal bones as these are better preserved and almost complete in the Laetoli Hominid 18 cranium. The results of these analyses are of interest since they involve the analyses of more than one character at a time and relates them to each other.

As shown by this study so far, the Laetoli Hominid 18 cranium is characterised by a long, flattened and widened frontal bone. As such, the cranium shows resemblances to the Omo I, Kabwe and Saldanha crania. The sub-Saharan modern crania unlike the Laetoli Hominid 18 cranium, present with relatively curved frontals. However, the Laetoli Hominid 18 cranium, like the modern *Homo sapiens* crania show some similarities in the length and breadth of the frontal bone. Those closely resembling the sub-Saharan modern group in frontal bone profile include the Fish Hoek, Matjes River, Singa, Djebel Irhoud and Keilor I crania. The Singa and Matjes River, however, unlike the sub-Saharan modern present with markedly constricted frontal bones. The Omo 2, Iwo Eleru, Florisbad and the Wadjak I crania unlike the Laetoli Hominid 18 cranium, present with relatively short and flattened frontal bones. In addition, the Iwo Eleru cranium presents with a constricted frontal bone as in the Singa and Matjes River crania. The classic Neanderthal crania such as the La Chapelle-aux-Saints and Le Moustier present with relatively curved, short and widened frontal

bones as are some of the Middle East archaic *Homo sapiens* crania such as the Tabūn I and Skhūl 5. The sub-Saharan *Homo erectus* together with the Pekin *Homo erectus* crania, unlike the Laetoli Hominid 18 cranium, present with relatively short, flattened and constricted frontal bones.

These analyses of the frontal bone in the different early hominid crania give a clear separation of these specimens. The Laetoli Hominid 18 cranium is thus well separated from the *Homo erectus* groups, the classic Neanderthal crania and from the Middle East early *Homo sapiens* crania. It is also interesting to note that some of the early African *Homo sapiens* crania such as the Omo 2, Iwo Eleru and Florisbad differ from the other early African *Homo sapiens* crania such as the Omo I, Kabwe, Saldanha and Singa crania in the frontal bone morphology.

The results of the analysis of the parietal bone unlike those of the frontal bone, present with slightly different pattern. The Laetoli Hominid 18 cranium is again characterised by long and flattened parietal bones. Closely resembling the Laetoli Hominid 18 cranium in the parietal bone morphology is the Omo I cranium. The sub-Saharan modern crania, together with the Fish Hoek, Matjes River, Iwo Eleru, Skhūl 5 and Keilor I crania, unlike the Laetoli Hominid 18 cranium, present with relatively curved parietals. The Singa cranium presents

with short and flattened parietal bones; thus confirming an earlier find by Stringer (1979). Those similar to the Singa cranium in the profile of the parietal bone include Kabwe, Omo 2, Saldanha and the Djebel Irhoud crania. The classic European Neanderthal crania such as the La Chapelle-aux-Saints and Spy 2, together with Solo I and the Pekin *Homo erectus* crania also present with relatively short and flattened crania compared to the Laetoli Hominid 18 cranium. The results of the parietal bone analysis seem to indicate that the Laetoli Hominid 18 cranium apart from its similarities in the parietal bone morphology to Omo I, greatly differs from the early African *Homo sapiens* crania such as Kabwe, Omo 2, Singa, Saldanha and Djebel Irhoud. These crania unlike the Laetoli Hominid 18 cranium show some resemblances in the parietal bone morphology to the Classic Neanderthaler crania, Solo I and to the Pekin *Homo erectus* crania.

C. MULTIVARIATE STATISTICAL ANALYSES (CANONICAL ANALYSIS)

Canonical variate analysis was employed as an aid in verifying the relationship of the Laetoli Hominid 18 cranium to both hominid fossils and modern crania. The technique leads to linear combinations of the original variables and maximizes the between-groups variations relative to the variation within groups (Bilsborough, 1973 and Campbell, 1980). As recently emphasised by Campbell (1980), the main aim of canonical variate analysis

is the separation or description of group differences, not of allocation of individuals.

In this study, it was only possible to use a maximum of ten variables out of the original 27 due to missing values. However, the usable variables though small in number described most of the main characters of the Laetoli Hominid 18 cranium.

The sample size in some of the comparative groups was small. The sample size depended wholly on the number of the available fossil crania and the state of their preservation, permitting accurate measurements. However, as recently stated by Campbell (1980), the groups with small sample sizes do not necessarily influence the results.

The canonical variate analysis derived six variates of which the first three encompass 97% of the total variability. The first axis (Fig. 21), encompasses 78.5% of the total variability and provides a good separation between the differing groups considered. Closer examination of Axis I (Fig. 21), reveals a continuous spread of the groups along this axis. Thus, the sub-Saharan modern, together with the sub-Saharan later Upper Pleistocene, the Middle East later Upper Pleistocene and the Far East/Australia Upper Pleistocene groups are close together and form a cluster at the negative end of the axis, whereas, the Pekin *Homo erectus* group is well separated from the rest of the groups and occupies the

positive end of the axis. Occupying a central position of the axis and close to each other are the sub-Saharan early Upper Pleistocene, the Middle East early Upper Pleistocene, the European early Upper Pleistocene and the North African Upper Pleistocene groups. The Laetoli Hominid 18 cranium is also well separated from the rest of the groups, but like the sub-Saharan early Upper Pleistocene, the Middle East early Upper Pleistocene and the European early Upper Pleistocene groups, occupies an intermediate position between the sub-Saharan modern and the Pekin *Homo erectus* groups.

Axis II, unlike Axis I shows a compact positioning of the different groups and encompasses 12% of the total variability. Subsequent canonical variates provide little effective group separation, as is evidenced by Axes III, IV, V and VI (Figs. 22-25).

Examination of the vector loadings of the original characters on canonical variates I-VI (Table 14), reveals that high loadings on these variates are those discriminating on the basis of both size and shape. Thus, similarities to/differences of the groups considered seem to be influenced by the overall size and shape of the cranium (character 4), the size and shape of the frontal bone (characters 1 and 8), the size and shape of the parietal bone (characters 2 and 11), and the degree of the development of the supraorbital torus (character 17).

The marked separation of the Laetoli Hominid 18 cranium from the Pekin *Homo erectus* group is mainly due to the overall size and shape of the cranium, the size and shape of the frontal bone, the size and shape of the parietal bone and the development of the supraorbital torus. Thus, the Pekin *Homo erectus* group as revealed by the univariate and bivariate analyses, together with the anatomical comparisons is unlike the Laetoli Hominid 18 cranium in having relatively shorter crania with short flattened both frontal and parietal bones and have much more marked supraorbital projection. The above features of the Pekin *Homo erectus* group seem also to separate the group from the rest of the other groups considered in this study.

The separation of the sub-Saharan early Upper Pleistocene group from the Laetoli Hominid 18 cranium is mainly due to the profile of the parietal bone. Thus, the sub-Saharan early Upper Pleistocene unlike the Laetoli Hominid 18 cranium have in general, shorter and more flattened parietal bones whereas the Laetoli Hominid 18 cranium has relatively long, flattened parietal bones. Apart from the differences in the pattern of the parietal bone between the Laetoli Hominid 18 and the sub-Saharan early Upper Pleistocene group, the specimens show much similarity in the overall size of the cranium, the shape and size of the frontal bone and the degree of development of the supraorbital region.

The sub-Saharan modern group, together with the sub-Saharan later Upper Pleistocene, and the Middle East later Upper Pleistocene groups, unlike the Laetoli Hominid 18 have relatively shorter crania with long and curved frontal and parietal bones. Moreover, the supraorbital development in the sub-Saharan modern and the sub-Saharan later Upper Pleistocene crania is only minimal compared to the Laetoli Hominid 18 cranium.

The separation of the Laetoli Hominid 18 and the North African Upper Pleistocene group lies in the morphology of the frontal and parietal bones, together with the development of the supraorbital torus. Thus, the North African Upper Pleistocene group, unlike the Laetoli Hominid 18 cranium, has relatively long and curved frontal bone while the parietal bone is markedly flattened and is short as in the sub-Saharan early Upper Pleistocene group.

The Far East/Australia Upper Pleistocene group differs from the Laetoli Hominid 18 cranium in the frontal and parietal morphologies whereby, the frontal bone in the former group is long and more curved as is in the sub-Saharan modern group and the parietal bone is relatively long and curved.

The European early Upper Pleistocene and the Middle East early Upper Pleistocene groups, unlike the Laetoli Hominid 18 cranium, have relatively short and curved frontals with short and flattened parietals.

However, the Laetoli Hominid 18 cranium shows some similarities with the above two groups in the overall cranial length and the degree of parietal flattening.

The relative positioning of the groups on each canonical axis as explained above, clearly demonstrate the nature of similarities to/differences between the groups considered. Referring to the separation on Axis I and considering the sub-Saharan modern group as a reference, the following relationship of the groups is shown. Closer to the sub-Saharan modern group and almost forming a cluster are the sub-Saharan later Upper Pleistocene, the Middle East later Upper Pleistocene and the Far East/ Australia Upper Pleistocene groups. Next follows the sub-Saharan early Upper Pleistocene group then the Laetoli Hominid 18 cranium. This is followed by the North African Upper Pleistocene, the Middle East early Upper Pleistocene and the European early Upper Pleistocene groups. The furthest group is that of the Pekin *Homo erectus*, this is well separated from both the sub-Saharan modern group and from the rest of the other groups.

The allocation of the Laetoli Hominid 18 cranium in relation to both fossils and modern crania was based on the total Mahalanobis's (D) distance, calculated from the canonical variate analysis (Table 15). The obtained results reflect a similar positioning of the groups as previously shown by the separation on Axis I above.

The Mahalonobis's (D) distance shows that the Laetoli Hominid 18 cranium and the sub-Saharan early Upper Pleistocene groups are equidistant from the sub-Saharan modern group. Although the two groups are well separated on the canonical variates, they still show more resemblances than differences between them than to any other group considered above.

The overall canonical analyses give a clear picture of the separation of the early African *Homo sapiens* crania including the Laetoli Hominid 18 cranium from the classic Neanderthals, the Middle East archaic *Homo sapiens* and the Pekin *Homo erectus* crania. The distinction of the early African *Homo sapiens* crania from the classic Neanderthaler crania has been shown by previous workers (Rightmire, 1976, 1978 and 1979; Stringer; 1974a and 1979).

D. TAXONOMIC CONCLUSIONS

This study of the Laetoli Hominid 18 cranium has led to a suggested conclusion concerning taxonomic affinity of this find. As discussed by Le Gros Clark (1954) and Campbell (1962), there are several problems encountered in the taxonomy of palaeontological materials. Some of these problems include the inadequacy of the methodology of taxonomy, the sparsity of the fossil record and the incompleteness of the fossil materials themselves. With the new discoveries of fossil hominids in Africa and elsewhere, the data of human evolution are rapidly

changing and broadening. Gaps in the hominid fossil record, which previously favoured the concept of branching evolutionary development, and a number of distinct taxonomic categories, are now becoming filled (Weiner and Campbell, 1964).

Any attempt to classify the Laetoli Hominid 18 cranium must take into account the total morphological as well as the metrical characters of the cranium. Both the morphological and the metrical features indicate that Laetoli Hominid 18 cranium presents with features of both *Homo erectus* and *Homo sapiens*. The archaic features of the Laetoli Hominid 18 cranium are localised, illustrating the mosaic nature of the later phase of skeletal development in the genus *Homo*. One set of these archaic features is seen in the frontal area and the other in the occipito-mastoid region.

The Laetoli Hominid 18 cranium resembles *Homo erectus* only in a limited number of features that include the recession of the frontal region, the smallness of the mastoid processes, the overall cranial length and the development of the occipitomastoid crest. Apart from the above features, the Laetoli Hominid 18 cranium shows features of archaic *Homo sapiens* and modern *Homo sapiens* crania. Features distinguishing the Laetoli Hominid 18 cranium from the *Homo erectus* crania include:

i) substantial reduction in the cranial bone thickness;

ii) general enlargement and elevation of the cranial vault;

iii) presence of posteriorly rounded and bossed parietal bones with maximum cranial breadth falling well above the mastoids in the bi-parietal region.

iv) reduction in the frontal bone keeling in the sagittal plane;

v) possession of a well rounded, filled occipital bone profile with the inion well shifted towards opisthion;

vi) reduction in a facial skeleton accommodated well below the pre-chordal segment of the cranial base;

vii) possession of a moderate pear-shaped nasal aperture associated with a nasal spine;

viii) moderately developed brow ridges well differentiated into its glabella, super-ciliary and supraorbital elements.

ix) general expansion of the brain as revealed by the size and shape of the endocranial cast. In addition, the meningeal vascular pattern, together with the venous sinuses conform to the modern *Homo sapiens* cranial pattern.

Consideration of the above features seems to place the Laetoli Hominid 18 cranium closer to the archaic *Homo sapiens* crania rather than modern *Homo sapiens* crania. Combination of statistical and morphological data all tend

to favour firmer links for the Laetoli Hominid 18 cranium with other archaic African *Homo sapiens* crania such as Kabwe, Eyasi I, Omo I, Omo 2, Singa, Florisbad and Saldanha. However, the Laetoli Hominid 18 shows more resemblances to Eyasi I and Omo I rather than with Kabwe, Omo 2 and Saldanha crania. The Laetoli Hominid 18 cranium as shown by the morphological and statistical data differs very much from the classic Neanderthaler crania from Europe, Middle East archaic *Homo sapiens* crania and Far East/Australia archaic *Homo sapiens* crania.

With the available fossil record in Africa today, it appears therefore that in the later part of the Pleistocene, the continent was once inhabited by populations that were widely spread and covered the eastern and the southern parts. In the eastern part of Africa, such populations are represented by the Laetoli Hominid 18 cranium, Ndutu, Kanjera, Eyasi crania, Kabua, Omo I and 2 and Bodo, whereas, in the southern part of Africa are Kabwe, Saldanha, Florisbad and Cave of Heaths. The available evidence of the fossil record in Africa then seems to support the 'spectrum hypothesis' identified by Weiner and Campbell (Weiner, 1958: Weiner and Campbell, 1964).

The general conclusion to be drawn from this study of the Laetoli Hominid 18 cranium is that the find is yet another early East African example of sub-Saharan *Homo sapiens* of Upper Pleistocene age.

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